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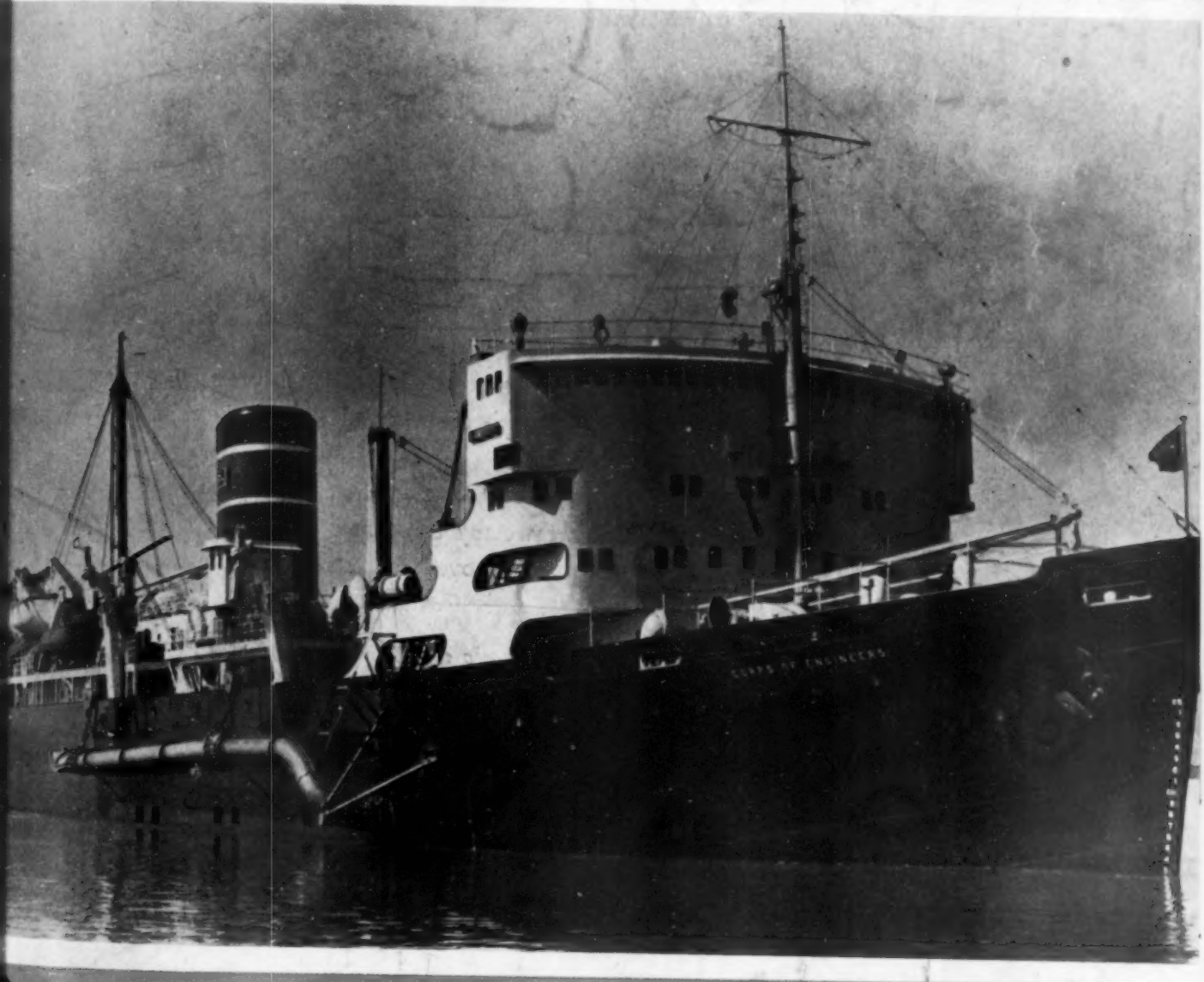
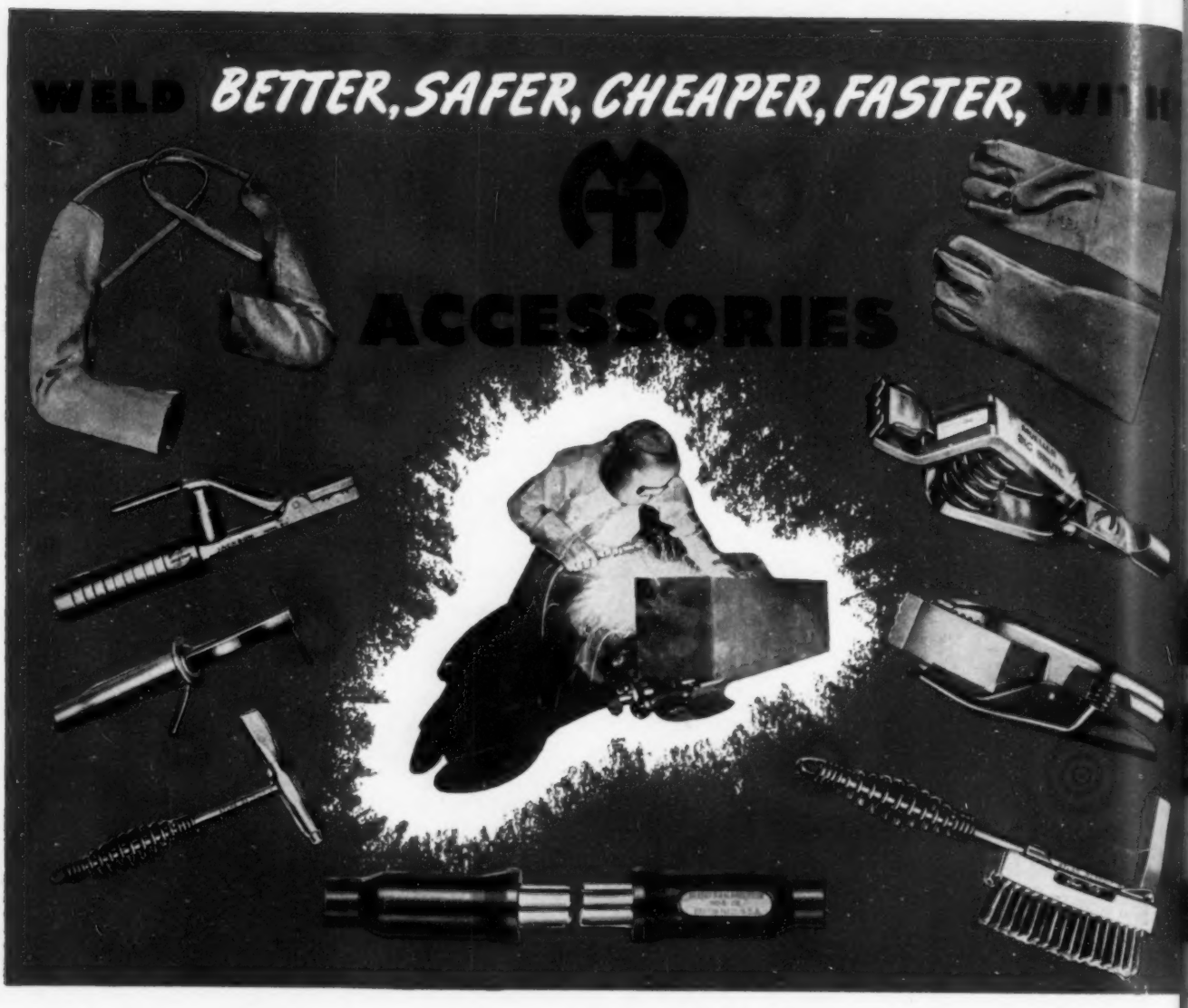
The WELDING Journal



The Journal of the American Welding Society



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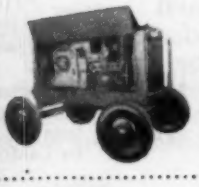

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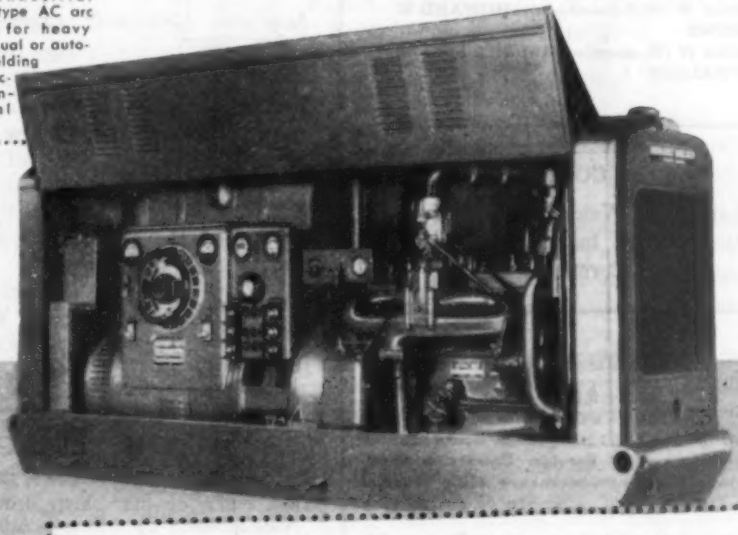

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Published for the Advancement of the Science and Art of Welding

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COVER

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The Journal of The American Welding Society

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The Story of the Welding Symbols

By Leon C. Bibber*

The article traces the development of Welding Symbols over the past 20 years. It explains clearly the purpose of the A.W.S. Symbols and how they may be used. The author emphasizes the changes in the symbols since the last standards were issued and their acceptance. The limitations of the Symbols are mentioned.

Introduction

IN THE early days of welding the advantages of this new means of joining metals were known to the shop through the use of welding as a repair and maintenance tool. Very slowly indeed did this knowledge climb to the level of the drawing office. When the designing staff became aware that a new factor had entered into the fabrication of metals, welding was tolerated, but the ignorance of the average draftsman of this new method was profound. Often, the drawing would be marked "weld" or "to be welded throughout" and the size and location of the welds left to the judgement of the shop. The men doing the actual work had no knowledge of the loads to be borne by the various parts, or of the strengths necessary, and often put on the excess in the wrong places and less than was necessary in others. Embarrassing failures sometimes resulted, and many engineers, skeptical of this new process, had their doubts confirmed. Also, the cost of such welding was exorbitant. It was only after the designing staff realized that welded parts must be designed just as carefully as any other, that the need was felt for a means whereby welding information could be conveyed from the drawing office to the shop.

This need resulted in the Committee on Nomenclature, Definitions and Symbols. This first committee published a pamphlet in 1929 entitled *Welding and Cutting Nomenclature, Definitions and Symbols*. In this pamphlet the original "hen track" symbols were introduced. The symbol section occupied four pages of the publication.

The Committee on Symbols subsequently split off from the Nomenclature Committee, and two separate committees were formed: the Committee on Symbols and the Committee on Definitions and Chart. The work of these two committees is still closely allied, and there is considerable interlocking of membership between the two.

It was considered desirable to have the AMERICAN WELDING SOCIETY's symbols adopted by the American Standards Association. However, before attempting this, it was deemed wise to increase the membership until the combined experience of the committee would cover practically all applications of welding. Accordingly, the personnel was selected to represent the steel industry, the telephone industry, the shipbuilding industry, the electrical industry, the structural industry, the pressure-vessel industry, the automobile industry, the resistance-welding industry, the heavy-machinery industry and the important fabricating agencies of the government such as the United States Navy Department and the United States War Department. The present personnel of the Symbols Committee is as follows:

L. C. Bibber, *Chairman*, Carnegie-Illinois Steel Corp.
L. M. Dalcher, Fairbanks-Morse Co.
S. A. Greenberg, AMERICAN WELDING SOCIETY
W. A. Bischoff, Bell Telephone Laboratories
Bureau of Ships, Navy Department
R. W. Clark, General Electric Co.
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H. M. Priest, United States Steel Corp. Subsidiaries
H. H. Troger, Federal Shipbuilding & Dry Dock Co.
C. B. Voldrich, Battelle Memorial Institute
R. A. Webster, Ordnance Dept., U. S. Army
V. S. Wielosinski, Willys-Overland Motors, Inc.

These gentlemen are at the same time members of the Sectional Committee on Graphical Symbols and Abbreviations for Use on Drawings, Z-32 of the American Standards Association.

In 1942 the pamphlet *Welding Symbols and Instructions for Their Use* was published. In this publication the ideographic symbols were introduced for the first time. This standard was adopted by the American Standards Association.

The instructions for the use of the symbols were presented in the form of rules. This method, while satisfactory from a specification viewpoint, made reading and explanation difficult. Accordingly, the committee undertook a step-by-step presentation of the rules in a more or less lecture form. Praise is due to the welding engineering staff of the United States Navy Department Bureau of Ships for making all the drawings and sketches used throughout the publication.

Thus the 1947 Standard Welding Symbols are the culmination of more than twenty years of effort and thought by many individuals.

A casual glance at the sixty-seven pages of the symbol pamphlet might give the impression that the system was very complicated and very voluminous. Probably there is no one who has seen the system who has not thought to himself that he could take fifteen minutes off some day

* Chairman of the A.W.S. Committee on Symbols.

and devise a better system than the one concocted by the Symbols Committee. In one sense this could be done, because, generally speaking, one user has in mind only the process with which he is concerned, and the type of work which he does. He is not thinking of the many different welding processes, the many different types of joints, and the many different applications. One of the most usual suggestions for a symbol system, particularly in the early developmental days, was that abbreviations be used. One example will suffice to show the fallacy of this idea. The letter "F" would unquestionably be used as one abbreviation. In welding practice the letter "F" could mean "fillet," "far," "flush" and "finish." Furthermore, the use of abbreviations would limit the symbol system to the English-speaking languages, and would not enable it to be international in scope, should other countries desire to use the system.

Actually, the scheme is not complicated. Once the basic principles upon which the system is founded are understood, the details of the individual symbols become merely simple applications of those principles. In order that the prospective user may gain a better grasp of the reasoning back of these principles, this article is written. It is hoped that an understanding of the system will help to remove any reluctance on the part of those who are hesitant about adopting the scheme.

In the 1929 symbols' system there were no real weld symbols for gas and arc welding. Hatching symbols, oftentimes called "hen tracks," were placed alongside of a line to indicate a fillet weld, or were placed on a line to indicate butt welds. Thus the scheme took care of only fillet welds and simple groove welds.

These arbitrary hatching symbols were used to designate the location of the weld, i.e., whether it was on the near side, the far side or both sides. There was no way of knowing which symbol applied to which location—one simply had to remember which was which. This was definitely a drawback, particularly for readers such as executives, inspectors and others not intimately concerned with welding details.

In this system the same basis for locating a weld was used as still obtains on certain structural drawings. On such drawings clips, parts, and the types of heads and points on rivets are designated as being on the near side or far side of the member upon which they are shown. This procedure, while satisfactory for clips, etc., gave rise to confusion when applied to welding, because often several members or flanges were shown by one view, and it was not clear which of the several was meant. Also, much welding was shown in cross section, in which case the welds on the two sides were equally distant from the reader, so that there was in reality no near or far side. Furthermore, near and far could apply to the joint as well as the member.

As the use of welding increased, the need for a means of calling for all types of welds arose. The German welding fraternity had for some years been using a mnemonic system, i.e., a system which assists the memory, wherein ideographs representing fillet welds, V-groove welds, etc., were shown on the lines of the drawing in the locations where the welds were to be placed. These picture-writing symbols showed exactly the type of weld desired, and were considered to be excellent for the purpose. However, it was felt that the application of these ideographs directly on the lines of the drawing would lead to confusion. It was decided that ideographic symbols would be used, but they would be placed on reference lines and connected to the lines of the drawing by arrows.

The use of ideographs removed the task of remembering which symbols stood for which welds. However, the problem of the location significance was not solved, because welded joints were still shown in cross section where the welds on either side were equally distant from the reader.

Arrow-Side and Other-Side Significance

After some years of deliberation, it was decided to make the *joint* the basis of location and not the member. When the joint is thus used, welds shown in cross section will be on one or the other side of the joint, just as much as welds shown in plan or elevation. Every joint which is symbolized has the welding symbol connected to the joint by an arrow. Thus every such joint has an *arrow* side and an *other* side (and also *both* sides), and the question as to whether near and far pertain to member or joint is eliminated.

When a welded joint is shown in *plan* or *elevation*, the joint is depicted on the drawing by a line, and the reader is on the near side of that line. The weld symbols, arrows, reference lines, etc., are never shown dotted, and accordingly, the welding symbol and its arrow are on the reader's side of the joint line.. As one looks at the welding symbol, the location below the reference line is on the near side of that line. Thus, symbols for welds to be located on the arrow side of the joint are placed on the near side of the reference line, and symbols for welds to be located on the other side of the joint are placed on the far side of the reference line away from the reader, and another rule to be remembered is eliminated. This condition will be true whether the drawing is read from the bottom or from the right-hand side, because to read the drawing the reader must orient himself with regard to all reading matter thereon.

In the 1942 Welding Standard the words "arrow (or near side)" and "other (or far side)" were employed to help the user in this reasoning. In the 1947 edition, however, it was felt that this principle had sufficient background so that the words *near* and *far* are either deleted or very greatly subordinated to the words *arrow* side and *other* side.

For welded joints shown in *cross section*, near and far, as has been pointed out previously, have no significance. However, the use of the near side of the reference line for the location of the arrow side symbol, and the far side of the reference line for the other side symbol, is consistent and so well established that there should be no confusion.

Since the joint is to be the basis of the location of the welds, it is necessary that the reader have a clear concept as to just what is the joint. Whatever may be the finally approved definition of joint, in essence joint will be considered as the location where the parts are to be joined. This broad concept may be satisfactory for a general definition, but for purposes of symbolization more specific illustrations are necessary. Therefore, the first row of sketches of the summary sheet* depicts the five different basic types of joints, namely, the butt joint, the tee joint, the lap joint, the corner joint, and the edge joint, and shows exactly what area or line is meant by the term joint. It will be appreciated that there are numerous variations of these different types of joints; two such variations are given for the corner joint.

Not only are the various types of joints shown, but welding symbols are connected to the joints by arrows so that the arrow sides and other sides of the joints can be labeled. It will be obvious, of course, that had the arrows pointed to the opposite sides of the joints, different locations of the weld symbols with respect to the lines would be necessary to obtain the same welded joints.

It has been pointed out previously that the welds are located with respect to the joint and not to the member. However, the symbol system is extended to cover oper-

* See A.W.S. *Standard Welding Symbols.*

ations which must be done on the members before the welds are made. This is shown in the right hand block which depicts a plug-welded lap joint. In this case holes must be punched or drilled in one of the members before welding, and the welding symbol points to the member and not to a side of the joint, thereby indicating that holes for the plug welds are to be punched or drilled into that member. The same principle is also true in the case of projection welding, where the symbol points to a member indicating that the embossments are to be made on that member. In the case of the slot and plug-welded joints the final weld will actually be on the arrow or other side of the joint; in the case of the resistance-welded joints the final weld has no arrow-side or other-side location, and hence no confusion can result.

Basic Weld Symbols

The basic weld symbols are divided into two groups: the arc and gas weld symbols and the resistance weld symbols. The arc and gas weld symbols show four basic types of welds: namely, the bead weld, the fillet weld, the plug or slot weld and the groove weld. These types are based on the geometry of the weld. The resistance weld symbols, however, are subdivided on the basis of the welding process involved.

A great deal of discussion centered around the bead weld. In the 1942 Symbol Standard square groove joints with beads deposited on one or both sides were considered to have been made by bead welds. In this present standard the square-groove joint is designated by the square-groove symbol, and is not considered to have been made with bead welds. The bead weld will be defined by the Definitions Committee as a weld deposited upon an unbroken surface or a weld deposited upon a jointed surface (other than a square groove) which has been welded from the other side, thereby becoming a virtual unjointed surface. When a bead weld is deposited on an unbroken surface, there is in reality no joint, and hence the significance of the arrow and other side of the joint is lost. The arrow and other side significance pertains then to the side of the member in question. However, seldom will this slight exception to the general rule cause trouble, because in most instances the location of the bead is unmistakable.

The bead on an unjointed surface finds considerable application as a marking device, such as the marking of draft numbers on the hulls of ships or the marking of annealing boxes that must go into furnaces, etc. The bead *type* of weld, however, has a number of other applications wherein it masquerades under two other names. When the bead weld is deposited on the back of a joint already welded from the other side, the bead is known as a back weld. When a bead type of weld is deposited on one side of an unwelded joint, that is not a square-groove joint, to form a foundation upon which the final weld can be deposited, this bead type weld is then known as a backing weld.

Backing welds deposited by the manual metal-arc process are often used in connection with joints to be welded by the submerged arc; the backing welds deposit sufficient metal to close the joints and prevent the submerged arc welds with their much greater heat input from melting through.

The very versatile bead weld symbol also performs another function. When surfaces are to be built up, as in the case of journals on shafting, pads, etc., the bead weld symbol is used in a dual form to indicate the juxtaposition of the beads.

In the 1942 edition of the Symbol Standard the bead weld symbol was not drawn to the reference line, but was raised slightly therefrom. In this present issue, the bead weld symbol is drawn directly on the reference line. The symbol thus becomes more ideographic, and also is distinguished from the convex-contour symbol (to be described later) which is not drawn to the reference line.

The fillet weld symbol is ideographic, and is very clear.

The plug or slot weld symbol is also ideographic, in that it represents the cross section of a countersunk plug weld. The symbol is nor so ideographic when applied to slot welds, because slot welds are seldom countersunk.

The groove weld symbols are all ideographic, and very obviously show the type of weld desired.

Not only can the arc and gas weld symbols indicate the welding for a joint that contains a single weld, but the basic weld symbols can be combined to show the many different types of welds that may be needed for one joint. Sometimes as many as four different welds are required for one joint. The different ideographs, therefore, become the building blocks for building up the combined weld desired by the designer.

The spot weld symbol is the only one which is not ideographic in some degree. A proper ideograph for a spot weld would be a circle. Such a circle would indicate a spot weld in plan or elevation, or could even be considered as representing a spot weld in cross section if a circle be considered a special form of ellipse. The use of the circle however, as a symbol is out of the question, because the circle is used to represent holes, rivets and other types of fastenings.

On many drawings the spot weld has in the past been indicated by a small cross. The spot weld symbol shown is that same small cross plus a vertical center line. Since a spot weld lies between the members being joined, spot welds have no arrow or other side location. Hence, the symbol is placed directly on the reference line. Also, in view of this fact, the spot weld symbol can be placed directly on the drawings, if desired. In other words, the use of this symbol is not confined to reference line.

A seam weld is usually a succession of overlapping spots, and hence the seam weld symbol is a succession of crosses. This symbol could readily be considered a conventionalized picture of a seam weld in plan, and therefore the seam weld symbol is to some degree ideographic.

The flash or upset weld symbol is ideographic in that it depicts the transverse joint between flash or upset welded members. Such welds cover the entire surfaces of the ends to be welded, and hence the symbol has no arrow- or other-side significance.

On the other hand, the projection weld, while similar in nature to a spot weld, must be called for by a symbol having arrow- and other-side significance, in that embossments or projections are made on one side or the other member. They could be made on both, but this is seldom done. Accordingly, the projection weld symbol uses the cross of the spot weld, but locates the cross either above or below the reference line in such a way that a projection is made in the reference line, thereby indicating ideographically the embossment to be made on the member.

On the summary sheet in the block containing the basic welding symbols are tabulated the various ideographs, together with their arrow- and other-side significance, or their lack of such significance.

Weld Details

Thus far we have seen what the weld symbols are and how they indicate the location of the weld with respect to the joint. However, much more information is necessary before the weld can be made; namely, dimensions giving the size, extent and other details of the welds. In evolv-

ing the scheme for giving the dimensions of welds, certain general principles were carefully followed:

1. The information must be clear and unmistakable. It is not enough to have welding symbols such that the shop staff, after the exercise of considerable judgment and effort, ultimately can arrive at the welding the designer desired. The symbolization must be such that the shop individual who wishes to misunderstand cannot possibly do so.

2. The most usual conditions need not be dimensioned unless desired. This principle has many examples, as follows:

(*a*) In single-V and other groove-welded joints, the most usual case is that where the weld extends completely through the joint. Accordingly, it is understood that when depth of welding is not dimensioned, complete joint penetration is desired.

(*b*) If the user has certain standard details, these can be called for without dimensions. For instance, in the case of the single-V groove joint mentioned above, if the user's standard practice is a sixty-degree included angle of bevel and a $^1/_8$-in. root opening, the use of the single-V symbol without dimensions is understood to call for the standard details. In the case of U-groove and J-groove welds, many other details such as the radius of the bottom of the groove, the root face and the included angle of bevel are handled in this manner. The symbol system provides no means of specifying the width and height of reinforcements. These details are to be in accordance with the user's standards.

It is, of course, appreciated that should one manufacturer's standards be slightly different than another's, the same symbol on the drawings of two different manufacturers could mean two different things. However, this is not a serious drawback, because, generally speaking, by far the greatest use of one company's drawings will be by that company. Should some central agency, such as a government bureau, use the drawings of many companies, a set of each company's standards can be secured.

(*c*) The most usual condition with regard to the length of a weld is that where the weld extends continuously from one end of the joint to the other. This condition is depicted by a symbol with no length dimension.

(*d*) The most usual condition with regard to reinforcements is that they are left in place. Therefore, unless otherwise specified, reinforcements are not removed.

Before the designer can use the symbols intelligently, he must know what the sizes of the various types of welds are. For convenience, just what is meant by size is shown parenthetically in the typical examples in the summary sheet. Size is always the first dimension shown.

One new concept has been introduced in the 1947 standard; namely, a means of indicating welds having root penetration. The manual and automatic metal-arc welding processes produce welds which extend little or no distance beneath the bottom of the chamfer, and hence the depth of the chamfer is a very good indication of the size of the weld. With processes using very high inputs, such as the submerged arc, it is possible to make welds which extend considerably farther. In order to take care of specific depths of root penetration two size dimensions are given: the first, the depth of chamfer; and the second, the root penetration. These two dimensions are joined by a plus sign, so that size remains one term and can be located properly on the welding symbol.

Length of Weld

The next important dimension that should be shown for the desired weld is length. Length can be indicated in many ways as follows:

(*a*) If no length dimension is given, the weld is to extend between abrupt changes in the direction of the welding; if no such changes obtain, the length of the weld is the length of the joint.

(*b*) The length of the weld may be shown by a length dimension on the welding symbol. The length dimension is always shown to the right of the weld symbol.

(*c*) The length of the desired weld may be shown by dimensions on the drawing, with the welding symbol placed between the arrowheads of the dimension line.

(*d*) The length of the weld may be indicated by the use of a hatching, and the hatching may be dimensioned for length or not, as desired.

Numerous examples showing the lengths of welds are given in the typical symbols on the summary sheet.

Intermittent Welding

In the case of intermittent welding, a third dimension is necessary; namely, the pitch or center-to-center distance between the increments. Pitch is always the second dimension shown, after the symbol except in the case of plug, spot and projection welding when pitch is the only dimension to the right of the symbol. The pitch of increments of staggered intermittent welding is always measured on one side of the joint, because in many applications the other side of the joint is not accessible, and measurements between increments on one side and the other is not possible. In the case of staggered intermittent fillet welding, the displacement of the fillet weld symbols graphically indicates the stagger.

With plug welds and slot welds another dimension is necessary; namely, the depth of filling of the hole. This dimension is placed inside of the weld symbol. If no such dimension is shown, the most usual condition is to obtain, namely, the hole is to be completely filled.

Root Opening

Another dimension is also placed inside of the weld symbol—that for root opening. One of the reasons for using the double line for the square groove weld was to enable the root opening dimension to be placed inside of the symbol. This dimension cannot be confused with that for depth of filling of plug welds, because the type of weld determines the meaning of the dimension.

In certain types of welds it is not feasible to give all the necessary information on the symbols. Such is the case with slot welds. The plug weld symbol is used to indicate slot welds, but the orientation of the slot weld, i.e., whether it is parallel to the center line of the joint or transverse or at an angle thereto, the length, width or any other details must be shown by a detail of the slot weld on the drawings.

Spots welds, projection welds and seam welds are between the members which they join, and are not visible for measurement. After a spot or projection weld has been made, there is no way of measuring its size except to destroy it. All that can be seen are the depressions on the outside, and these may or may not be a true indication of the size of the weld. Accordingly, a somewhat different procedure is used in the case of these types of welds. In order to determine welding machine settings, two criteria may be used; namely, strength and size. If the user wishes to conduct tension shear tests on spot welds made with the proposed welding-machine setting, the desired weld size may be designated on the symbol by strength in pounds per spot. If the user wishes to twist his trial spot welds to destruction or to cross-section them, he may measure diameter, and then

his drawings may call for the welds by diameter in terms of hundredths of inches.

In the case of seam welding cross sectioning is the most usual method for determining the size of the weld, and accordingly the size may be called for as the width of the nugget in hundredths of inches. The size of seam welds may also be specified, if desired, in terms of pounds per inch of weld.

Flash or upset welds are generally made over the entire cross sections of the parts to be joined, and accordingly size has no significance, with these processes.

Use of Weld-All-Around Symbol

Not only is the above information pertaining to type, location, size, length, etc., of the welds necessary, but often certain supplementary information is desired. For example, a very usual condition exists in construction where a weld is wanted completely around a tubular member or an I-beam or an irregular shape, and the use of many arrows to take care of the welding between abrupt changes in direction is objectionable. Accordingly, the weld-all-around symbol ideographically shown by the open circle is very useful.

Field Welding

As in the case of riveting, certain joints often are not to be welded in the shop, but are to be later welded in the field. In order to convey this information, the black dot which has been used for so many years to indicate field riveting is used to call for field welding.

Finish Marks

Unless otherwise indicated, welds are to be left as welded, i.e., they are not to be finished in any way. If they are to be finished, the first information needed is with regard to the contour to which they are to be finished. A very usual condition is that of making groove welds flush with the adjacent plate surfaces. This can be done by various mechanical means. However, it is often desired to have the weld as flush with the surrounding surfaces as is possible without recourse to mechanical finishing. The use of the flush-contour symbol without additional information as to the means of making the surface flush, indicates that the welder is to take special pains in depositing the weld, so that it will be as flush as possible.

If it is desired to specify the means by which mechanical finishing is to be done, letters indicative of the means may be used, such as "M" for machining or "C" for chipping or "G" for grinding. It will be noted that these letters indicate the means and not the degree of the finishing. Should the user wish to give more specific information as regards the degree of finish, this can be done by using any of the finish designations which may be specified by other technical societies responsible for those standards.

If it should be desired to retain the original convex contour of the weld reinforcement, but at the same time require some degree of mechanical finish, this can be done by using the convex contour symbol, together with the letter indicating the desired means of finishing. While the convex contour symbol is similar in shape to that of the bead weld, the contour symbol is never used on the reference line, but only on the weld symbol.

Welding Symbols

Thus far we have dealt with weld symbols, their location, significance, dimensioning, supplementary symbols, etc. It is time now to consider the welding symbol as a whole. The distinction should be clearly borne in mind between a weld symbol and a welding symbol. A weld symbol is simply the symbol for a weld. The welding symbol is an entity made up of eight component parts:

1. The reference line.
2. The arrow.
3. The basic weld symbol.
4. Dimensions and other data.
5. Supplementary symbols.
6. Finish symbols.
7. Tail.
8. Specification, process or other references.

Each of the above items has a standard location on the welding symbol. These standard locations are clearly shown on a general welding symbol on the summary sheet. The various elements should always be placed in their standard locations, because location often has as much significance as the symbols and other data.

Processes for Which Symbols Applicable

The earlier editions of the welding symbols were concerned only with gas and arc welding and resistance welding. The present issue of the standard can encompass all the welding processes listed below:

1. Shielded carbon-arc welding.
2. Inert-gas carbon-arc welding.
3. Carbon-arc welding.
4. Twin-carbon arc welding.
5. Shielded metal-arc welding.
6. Impregnated-tape metal-arc welding.
7. Atomic-hydrogen welding.
8. Inert-gas metal-arc welding.
9. Submerged-arc welding.
10. Stud welding.
11. Bare-metal-arc welding.
12. Air-acetylene welding.
13. Oxyacetylene welding.
14. Oxyhydrogen welding.
15. Flow welding.
16. Pressure-thermit welding.
17. Nonpressure thermit welding.
18. Roll welding.
19. Die welding.
20. Hammer welding.
21. Spot welding.
22. Seam welding.
23. Projection welding.
24. Flash welding.
25. Upset welding.
26. Percussion welding.
27. Induction welding.
28. Torch brazing.
29. Twin-carbon arc brazing.
30. Furnace brazing.
31. Induction brazing.
32. Resistance brazing.
33. Dip brazing.
34. Flow brazing.

In some cases the geometry of the desired welds requires the use of weld symbols, as in arc and gas welding, and in some cases the final shape of the weld is peculiar to the process, and the process itself is of major importance.

Table 1—Tabular Specification for Individual Joints

		Pre-Welding				Welding				Post-Welding	
Spec. No.	Welding Process	Special Local Cleaning	Use of Anti-splatter Prepa-ration	Use of End Tabs	Pre-heat	Type of Filler Metal	Flux	Root Chipped	Peened	Inspection	Special Clean-ing
Ma 1	Metal-Arc	Grit blast	Yes	Yes	350° F.	A.W.S. E6010	.....	Yes	Yes	Magnetic particle	Rotary wire brush
Ma 2	Metal-Arc	None	No	No	None	A.W.S. E6015	.....	No	No	X-ray	JKL fluid
G-1	Gas	.....	....	..	...	A.W.S. GA60	JKL #22	Yes	...	.....	...
Ma 3	Submerged arc	Drying flame	No	Yes	None	FGH #13	200XD	No	No	None	None
B 1	Induction brazing	RST fluid	No	No	None	XYZ #20	ABC #3	.....	...	.....	Acid
F 2	Flash	.....	....	..	None	....	.....	.....	...	.....	...
C-4	Carbon arc	None	No	No	None	None	NNO #14	Yes	...	Penetrating oil	None

Accordingly, the tail of the welding symbol is the location selected in which to place process references. These references can be codified in various ways to suit the individual user. The use of the welding symbol with a process reference shows that a weld is to be made, and shows the process by which it is to be made.

Use of Tail of Arrow

However, the tail of the welding symbol can be used for many purposes. Since the tail has no arrow- and other-side significance, notes which pertain to the joint as a whole can be placed therein. On the other hand, should a note or reference have special arrow- or other-side significance, a notation can be placed on the corresponding side of the reference line.

If a welding operator knows what type, what size and what length of weld is to be made and in what location, he still would not be able to deposit a single pound of weld metal without a great deal more information. He would not know, for instance, what electrode he was to use, whether or not the weld was to be peened, whether or not preheating was to be done prior to the welding, whether or not the weld was to be cleaned in any special way, or whether anti-spatter preparations were to be applied prior to welding, or whether the root of the weld was to be chipped. This information can all be given in the tail of the welding symbol in the form of tabular specifications, as shown in Table 1.

All users may not wish to use a tabular specification in so much detail, or there may be others who will desire more detail. The tabular specification can be made to suit the user's requirements, and can be identified by his own specification numbers. These tabular specifications can be traced on the drawing—only such as are applicable to the particular drawing need be used—or the tabular specification can be placed on practice sheets or handled by any other means the user desires. Table 1 is included herein as an indication of one way in which the welding symbols can be used to their fullest.

You will note in Table 1 a column for "Inspection," in which X-ray or magnetic-particle or penetrating oil inspection is called for. Symbols to indicate these various inspection methods are already under consideration. It is probable that the inspection symbols will follow the general pattern of the welding symbols, so much so, in fact, that combined welding and inspection symbols can be made. As soon as the various organizations involved in these methods of inspection can crystallize their ideas into a symbol system, the column for "Inspection" may no longer be needed.

Factors Not Shown by Symbols

It will be noted that all the items in Table 1 are those pertaining to an individual weld or joint. The table does not contain such requirements as general preheating or postheating or painting or general sand blasting for the very good reason that those requirements pertain to the weldment as a whole, and not to the individual weld. The items listed above can be called for on drawings by general notes.

Neither the symbol system nor the tabular specification shown in Table 1 gives data concerning the sizes of electrodes that are to be used, the currents, voltages or polarities, the number of passes, gas pressures, welding speeds, electrode pressures, welding times, etc. Those factors come more within the province of standard practices and quality control, and are often established on the basis of economy. In other words, the welding symbols are concerned with getting the right quantities of weld metal in the right places; the quality of that weld metal must be taken care of by the established practices of the user.

Oftentimes individuals become so imbued with the idea of using symbols that they try to almost eliminate the drawing. For instance, suggestions have been made that the symbols show whether or not backing straps are to be used, and, if so, the size and thickness of those straps. It is the function of the drawing to show the geometry of the parts and their relation to each other, and to supply the information necessary for the ordering of material. Size of parts should not be shown on welding symbols.

Sometimes enthusiastic converts try to make the scheme fit special conditions. The symbol system is not intended to cover such special cases—only the great majority of usual situations. In symbolizing a drawing the same sort of judgment must be used that would be used in dimensioning that drawing; that is to say, the symbols must clearly and adequately show the workman just what the designer has in mind. If extra details and special sketches are necessary, then they must be made just as would be the case with dimensioning.

Conclusion

It is believed that the 1947 edition of *Standard*

welding symbols provides the user of welding with a shorthand system which will enable him concisely and precisely to convey the information from the mind of the designer to the hand of the workman. The ideographic symbols have now been in use many years, and long experience with them has testified to their merit. Their adoption is at present widespread. Most major structural companies, shipbuilding companies, earth-moving-machinery manufacturers, government agencies (the joint Army-Navy Standard 19 is identical to that of A.W.S.) and many other types of fabricating companies have adopted the system. More are being continually added to the list as their appreciation of the benefits of symbolization grows.

The Standard Welding Symbols of the AMERICAN WELDING SOCIETY are now so well established that it is believed only possibly very minor changes should be necessary for many years. It is highly desirable that changes be kept to a minimum, because the symbols will be incorporated into textbooks, manuals, standards, etc., and changes would make those publications obsolete. Also, many changes would tend to shake the confidence of the user in the system. The Committee on Symbols will strive to keep the changes to a minimum over the years.

End Hardening of Rail Ends and Open Hearth Frogs*

By R. W. Torbert†

THE investment of railroads represented in the rail per mile of track is constantly increasing. The use of heavier rail sections is the cause. To justify this increased investment, greater life must be secured from the rail. The width of the head of the modern rail section is unchanged. As a result the resistance to batter at the rail ends has not increased. Rail-end hardening is necessary to improve the resistance to batter.

Rail steel is a fairly high-carbon steel, in the weights of 91 to 120 lb. per yard running 0.67 to 0.80% and in the weights of above 120 lb. per yard 0.69 to 0.82%. The majority of rails used by Class One railroads today are rolled in sections weighing 100 lb. per yard and over.

* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† The Oxweld Railroad Service Co., Chicago 1, Ill.

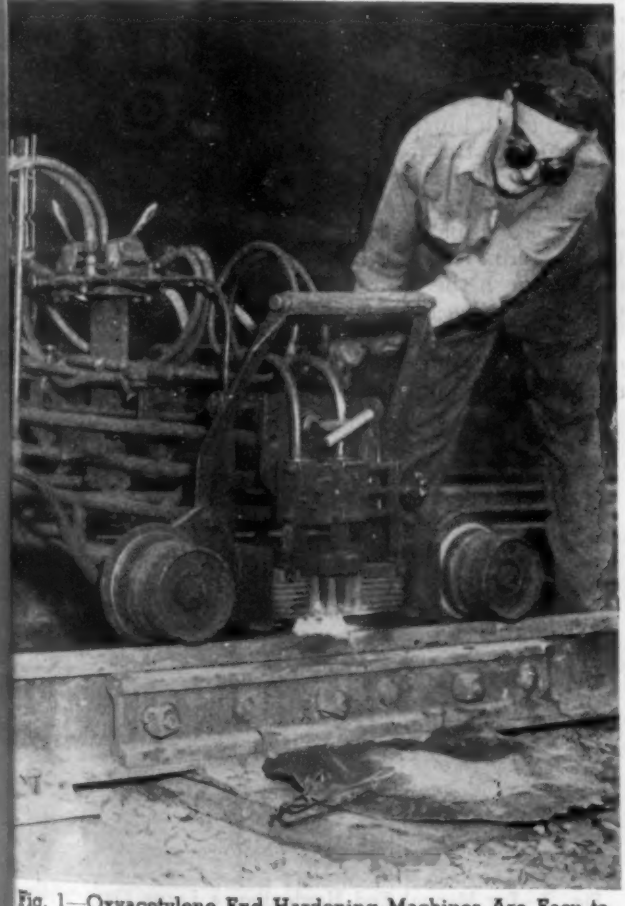


Fig. 1—Oxyacetylene End Hardening Machines Are Easy to Roll from Joint to Joint

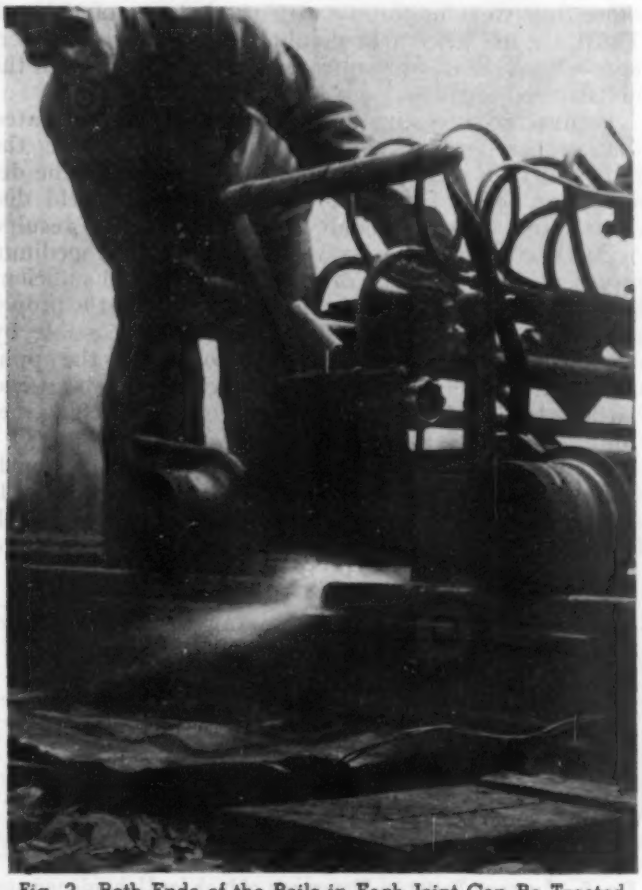


Fig. 2—Both Ends of the Rails in Each Joint Can Be Treated Simultaneously

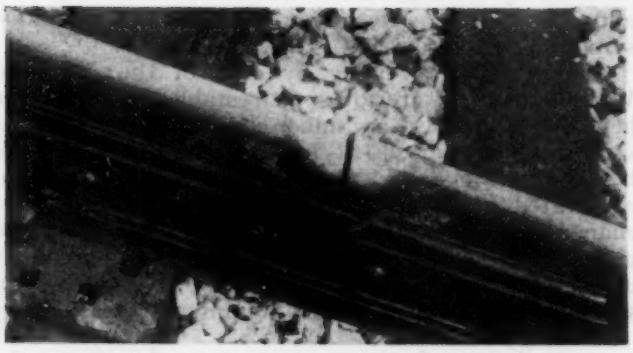


Fig. 3—The Heated Area Is Shaped Like a Butterfly Wing with the Longer Edge on the Gage Side of the Rail

Brinell Hardness Pattern

351	255	262
340	321	340
340	332	351

Fig. 4—Rail End No. 22, 131-Lb. Rail. This View of a Treated Rail End Shows the Hardness Pattern

The hardened area of rail ends must have three characteritics. First, it must be tough and have sufficient depth to provide longer service life. Second, it should have sufficient hardness to retard wear, and at the same same time wear uniformly with the balance of the rail. Third, the hardened area should have a pattern that permits a uniform transition from the hardened area to the unhardened area.

Preliminary investigation in the early 1930's indicated that proper hardness could be obtained by heating the rails and then using a water-quench to produce the desired hardness. However, operations in the field disclosed that it was difficult to obtain uniform results.

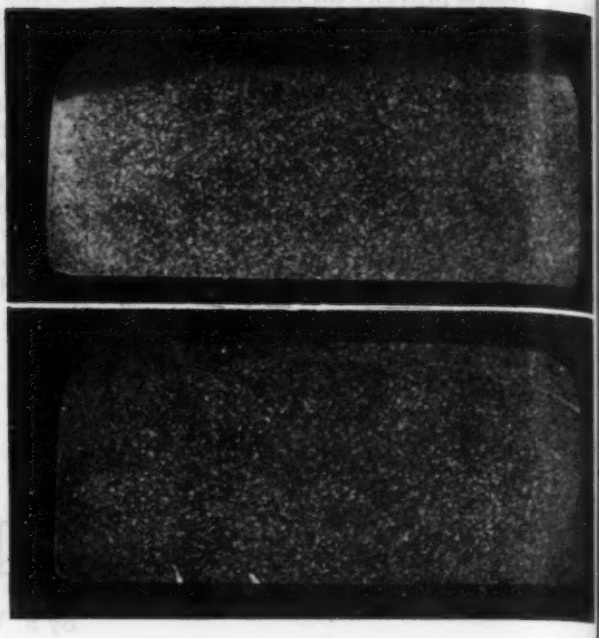
Further investigation showed that a quenching medium, represented by the mass of rail itself, provided sufficient hardness when the metal was heated quickly in the proper pattern. The quick heat input was made possible by che use of oxyacetylene flames. By controlling the application of heat alone, millions of rail ends have been end hardened, with the rail itself as the only quenching medium.

Machines of special design are used for the end hardening operation. These machines, as shown in Fig. 1, are mounted on four-wheel trucks and are easy to roll from joint to joint. The hardening heads consist of two

Date of Check	June 1939	April 1942	May 1945
Cumulative traffic, million tons	1.85	125.0	267.3
Rail ends hardened by Oxweld process	Lv. 5.62 Rec. 7.96 Av. 6.79	Lv. 10.8 Rec. 4.1 Av. 7.45	Lv. 15.3 Rec. 8.6 Av. 11.9
Unhardened rail ends	Lv. 7.67 Rec. 11.9 Av. 9.79	Lv. 14.2 Rec. 12.0 Av. 13.1	Lv. 23.9 Rec. 20.0 Av. 22.0

Fig. 6—Average Batter in Thousands of Inch for Unhardened and Hardened Rail Ends Are Shown for a 6-Yr. Period

(Top) Section 1/4 in. from end.



(Bottom) Section 1 in. from end.

Fig. 5—The Hardness Runs to About 1/4 In. Below the Running Surface of the Rail

adjustable blocks, each with three large oxyacetyle heating tips. This makes it possible to treat both en of the rails in each joint simultaneously. Four of t tips are at the gage or inside of the rail, while the oth two are at the outside of the rail as shown in Fig. 2. similar set of tips is mounted on the opposite side of t machine so that the joints in two rails can be treated wit out lifting the machine. The heating heads are mov laterally across the head of the rail by a hand-operated o cillating mechanism. This prevents burning during t heating operation. The heated area on each rail end shaped like a butterfly's wing with the longer edge on t gage side of the rail. This pattern is shown in Fig.

It is not necessary to liquid-cool the heating assembl A copper baffle plate spaced between the outside and i side tips dissipates some of the heat in this assembl Five manifolded acetylene cylinders and one oxygen cy inder furnish the required oxygen and acetylene throug the distribution box on the heat-treating machine.

The rate of production under this procedure is abo one joint per minute. This includes the time requir to move from joint to joint. A hardness of from 340

Fig. 7—For Manual End Hardening, a Large Oxyacetylene Welding Blowpipe and Baffle Are Required

380 Brinell is obtained The hardness pattern in Fig. 4 shows that the treated area is hardest at the gage of the rail. The hardness runs to about $^1/_4$ in. below the running surface of the rail. This is shown in the cross-section views of the rail end, in Fig. 5. It can be seen here that the hardness penetrates deeper at the gage of the rail.

It is characteristic of this type of treatment that the zone of transition between hardened zone and the underlying untreated metal is comparatively broad. This prevents separation of the metal in this zone under repeated loads. Another important characteristic is that the hardness is obtained without the formation of martensite microstructures. The table in Fig. 6 shows the average batter in thousandths over a 6-yr. period for unhardened rail ends and rail ends hardened by the Oxweld process.

There are two general methods for end hardening rails in track. The first is to permit traffic to run over the untreated rail for a period of time, determined by the batter

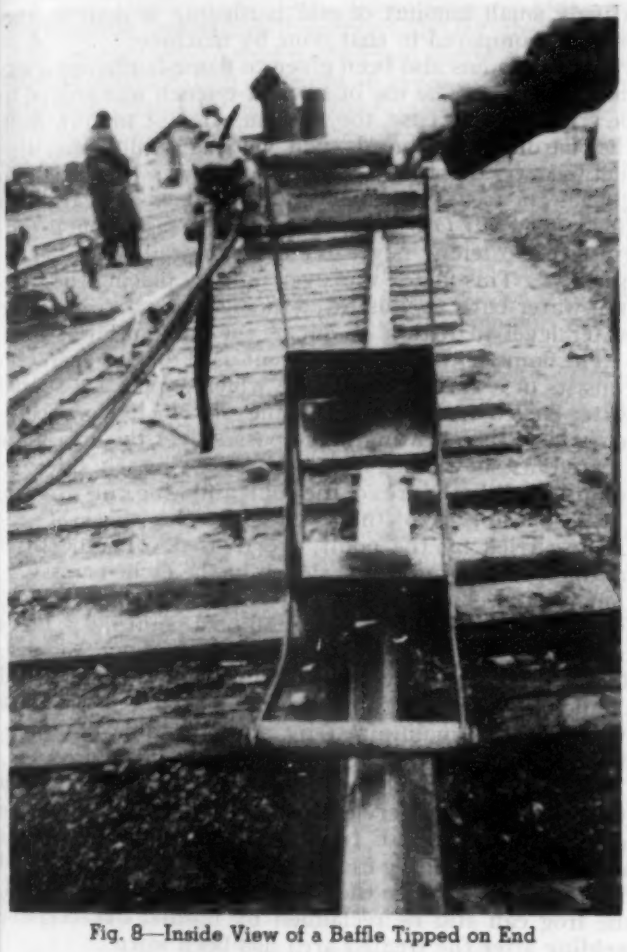


Fig. 8—Inside View of a Baffle Tipped on End

Fig. 9—A Semicircular Pattern Is Produced by Manual End Hardening

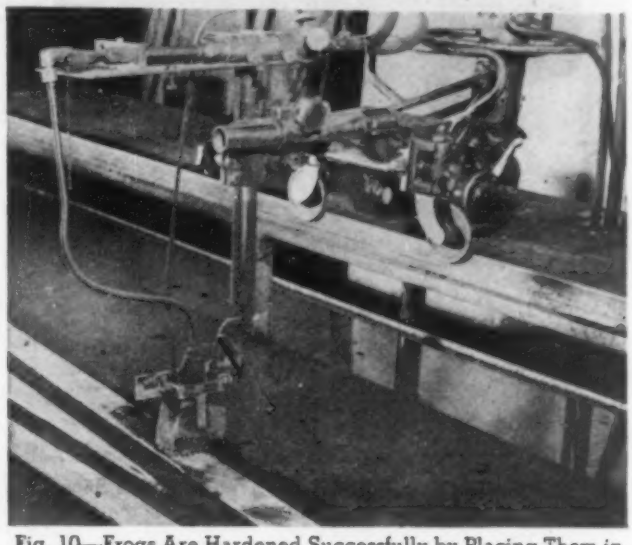


Fig. 10—Frogs Are Hardened Successfully by Placing Them in a Water Bath. The Water Level Is Kept to Within $^1/_4$ In. of the Frog Surface

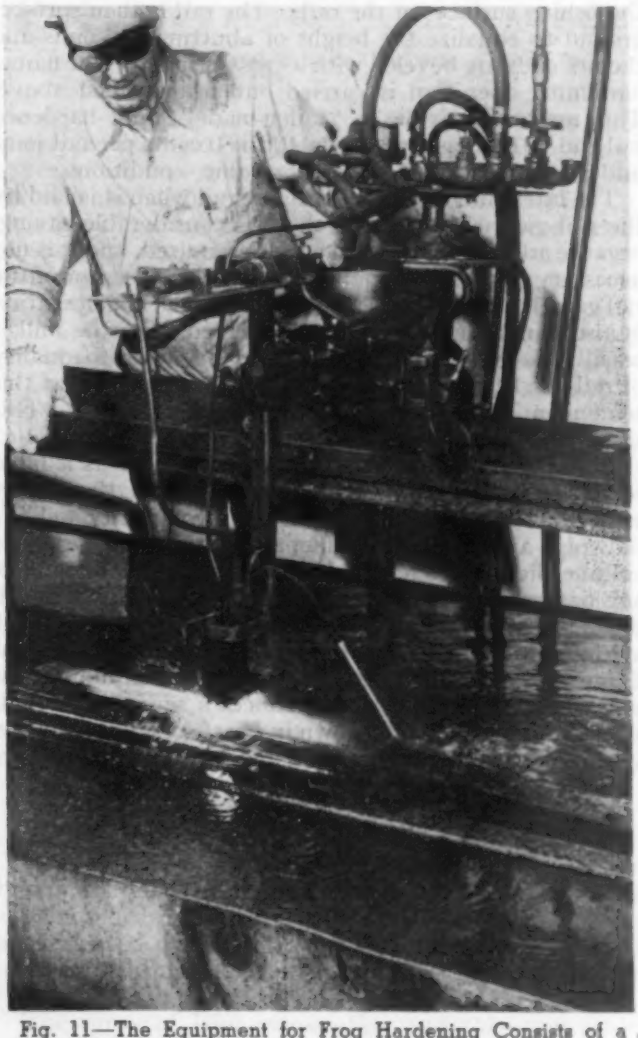


Fig. 11—The Equipment for Frog Hardening Consists of a Traveling Carriage and a Special Water-Cooled Oxyacetylene Heating Head

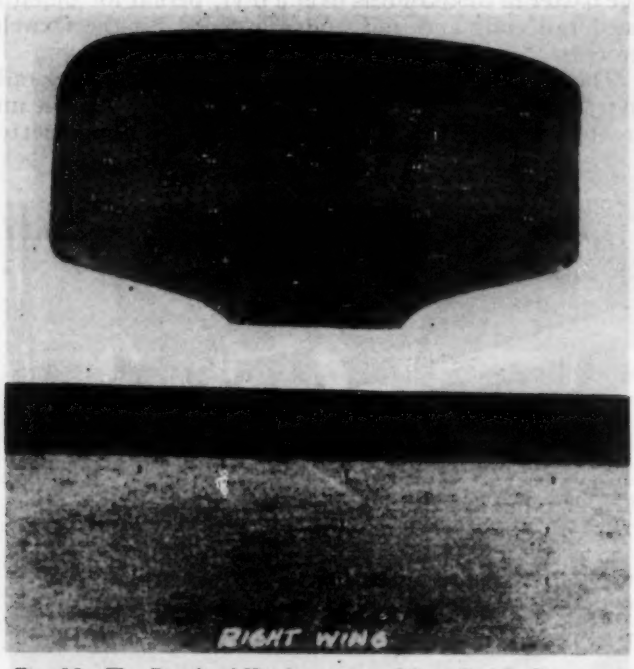


Fig. 12—The Depth of Hardness on a Wing Rail Is Shown in This Etched Cross Section

developed from the tonnage carried. This permits some cold-rolling and allows the angle bars to become seated in the fishing surfaces of the rail. The rail is then surface-ground to equalize the height of abutting rail ends and the rail ends are beveled with a cross-grinder The flame-hardening operation is carried out as described above. This method provides a "tailor-made" flame-hardened rail end. The cost runs from 40 to 60 cents per rail joint under present-day costs and traffic conditions.

The latest method is to treat the rail when it is laid by the rail gang. Obviously, there is considerable saving because additional flag men are not required, and it is not necessary to protect signal bonds. The supervisor of the rail gang handles this operation. The beveling operation is also eliminated because rail received from the mill is usually beveled. No correction is made for inequality of rail heights, but many railroad engineers feel that this refinement is not worth the additional expense. This method costs from 25 to 35 cents per rail.

Rail-end hardening can also be performed as a hand operation, but only when the operator is thoroughly trained. This method requires a large capacity welding blowpipe and a suitable baffle, as illustrated in Fig. 7, to confine the heat to a proper pattern. An inside view of the baffle box is shown in Fig. 8 The pattern is developed by moving the blowpipe in small circles on each side of the joint. To avoid overheating the edges, the flame is kept a short distance from the rail ends. The movement of the blowpipe produces a semicircular pattern on each rail end as shown in Fig. 9. While a correct time cycle for heating has been developed, the results are

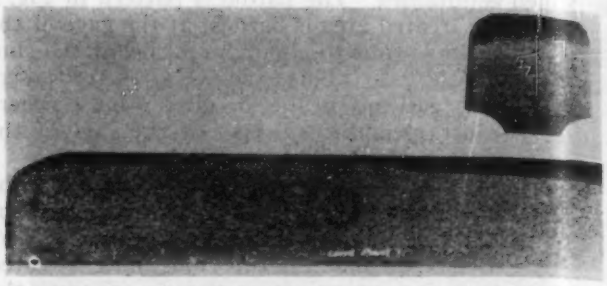


Fig. 13—This Etched Longitudinal Rail Section Shows the Hardness Runoff on a Point Rail

still dependent upon the ability of the operator. A relatively small amount of end hardening is done in this manner compared to that done by machine.

Attention has also been given to flame-hardening open-hearth frogs. The use of a water-quench was proved to be erratic in this case, too, and an attempt to draw back the hardness produced such varying results that this method was discarded. An attempt was then made to quench the treated area by conducting heat away through the base metal. Obviously the relatively high input in progressive hardening is greater than the rail can dissipate quickly. This factor was overcome by placing the frogs in a water bath as illustrated in Fig. 10 and keeping the water level to within $1/4$ in. of the frog surface.

The flame-hardening equipment used for this operation consists of a traveling carriage which supports a special water-cooled heating head using 20 No. 56 oxyacetylene tips. The heating flame passes over the area to be treated, as shown in Fig. 11, at approximately 6 in. per minute. Only the area of the point and wing rails from the throat of the frog to the place where the wheels are entirely carried by the point, are treated. The depth of hardness on a wing rail is shown in the etched cross section in Fig. 12 The etched longitudinal rail section, Fig. 13, shows the hardness runoff on a point rail. Frogs treated in this manner wear evenly without warpage. The water tanks may be constructed of sheet iron and should be large enough to accommodate the frogs. The water level is maintained by an adjustable drainpipe, with fresh water being continuously introduced.

Frogs treated by this process have given more than four times as much service as untreated frogs in the same location. The cost of treating a No. 10 100-lb. frog is about $7.00, including the cost of handling the frog to and from the tank. Since the underlying metal is unharmed, the frog can still be reclaimed by normal oxyacetylene welding after the treated area has been worn.

This same procedure is used to flame-harden other portions of the switch construction, such as the frog guard rails, special crossing frogs and switch point stock rails. The cost of the operation is so small compared to the increased life, that large reductions in railroad maintenance expense are possible. No other expenditure will provide benefits as great as the flame-hardening of open-hearth track members.

Mechanized Inert-Gas-Shielded Arc Welding*

By H. T. Herbst†

THE inert-gas-shielded arc-welding process, recently introduced commercially for the welding of magnesium, has made rapid strides in entering the field of fabrication of nearly all types of metals. One outstanding characteristic is the fact that, with the exception of copper, flux is not required in the welding of any of the common commercial metals and alloys. Some of the most notable applications of the process, from the standpoint of volume of goods produced, have been mechanized operations where high welding rate and large volume output are attained. The purpose of this paper is to describe the basic principles in designing for this type of operation. The application of these principles will be illustrated by specific examples.

As the name implies, the inert-gas-shielded arc-welding process is an electric arc-welding method in which the electrode and the weld are blanketed by an inert gas. While for mechanized operation the electrode might be either filler metal, as in metal arc welding, or a nonconsummable electrode, the filler-metal electrode is still in the experimental stages and has little commercial application. The nonconsummable electrode has had widespread production use. It may be either carbon or tungsten. Carbon has had some limited use in welding of stainless steel but tungsten is the more suitable and most frequently used material. The tungsten electrode is used in all applications described in this paper.

The inert shielding gas can be argon for all metals. Helium can be used for all metals but aluminum. Magnesium can be welded using direct current, reverse polarity, in which case helium is very satisfactory. Better results are obtained, however, when magnesium is welded with alternating current. Then argon is more satisfactory. Stainless steel, silicon steel, and other alloy steels can be welded with either argon or helium. Argon appears to be favored for hand welding and for the welding of material thinner than about 0.030 to 0.040 in. At equal welding rates, argon is generally more economical, in that the consumption rate is from one-third to one-half as great as when using helium. In mechanical welding without filler metal, when using argon particularly on stainless steel, undercutting limits the rate of welding in the range of 0.030 to 0.065 in. thickness.

* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† Development Engineer, The Linde Air Products Co.

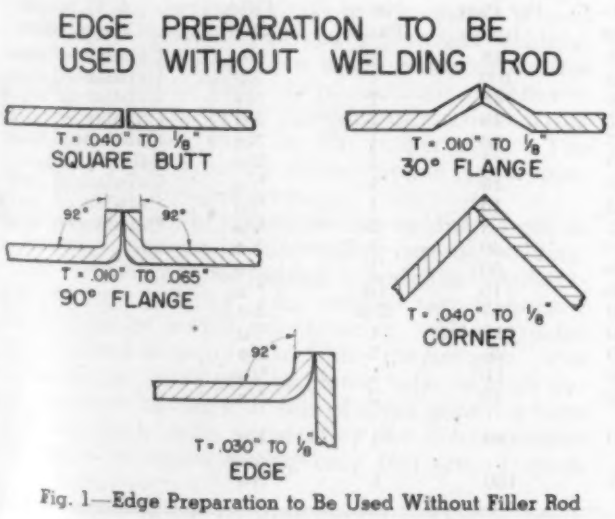
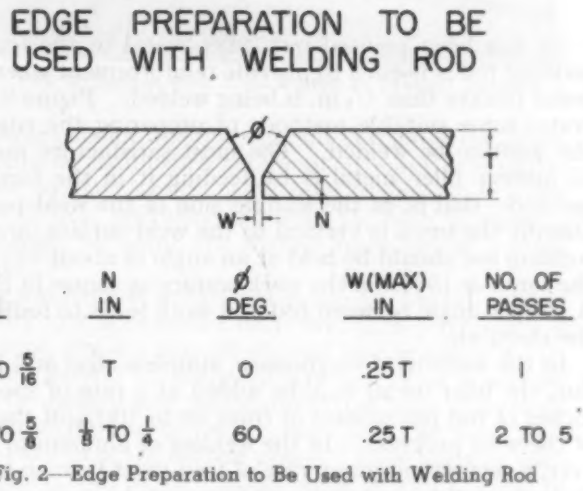


Fig. 1—Edge Preparation to Be Used Without Filler Rod



T IN	N IN	Ø DEG.	W(MAX) IN	NO. OF PASSES
1/16 TO 5/16	T	0	.25 T	1
5/16 TO 5/8	1/8 TO 1/4	60	.25 T	2 TO 5

Fig. 2—Edge Preparation to Be Used with Welding Rod

The term mechanized welding, will be taken in this paper to mean welding in which relative motion and distance between the welding torch and the work is produced by mechanical means. Relative motion between the two may be obtained by moving either the work or the torch. As in any electric arc-welding process the arc length must be held within certain limits. In this process it is possible to control the length of the arc automatically by electrical means actuated by the arc voltage. However, the majority of the applications of the process have been such that the jigs and fixtures necessary to hold the work have made automatic electrical arc control unnecessary. Therefore, all of the methods and procedures to be described are usable without this type of control.

Joint Types—Without Welding Rod

While in many instances the use of welding rod is optional, the equipment needed and procedures employed are simplified if a rod is not used. The use of a rod can be dispensed with if without it (1) sufficient weld thickness can be attained, and (2) proper fusion together of the edges results.

The types of joint preparation and thickness under which these conditions are met are shown in Fig. 1. In

brief, this indicates that butt joints in material up to 1/8 in. in thickness may be welded without filler metal if fitup is satisfactory. It also indicates that proper fusion together may be expected on these materials if the maximum gap between the parts does not exceed one-tenth the thickness. On very thin material this tolerance becomes quite small. Where it cannot be met, turned-up edges can be used to supply additional metal to fill the loose-fitting edges. Where fabrication difficulties or the design prohibit this, filler metal in the form of welding wire must be used. These generalizations apply to butt- and lap-type joints, and, with the exception of the use of filler metal, to corner- and edge-type joints.

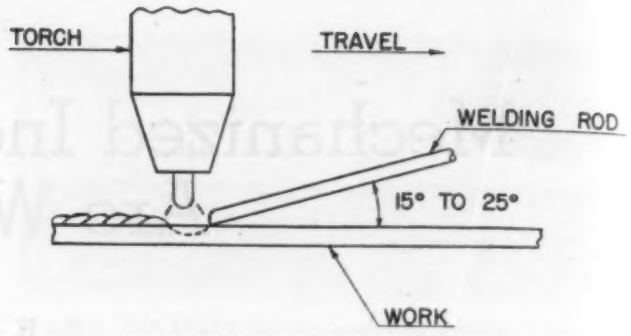


Fig. 3—Method of Adding Welding Rod

Joint Types—Using Welding Rod

As has been pointed out, filler metal in the form of welding rod is needed to provide reinforcement when material thicker than 1/8 in. is being welded. Figure 2 illustrates some suitable methods of preparing the edges of the joint to be welded. The most satisfactory method of adding filler metal is by feeding it in the forehand method—that is, in the leading side of the weld puddle. Usually the torch is vertical to the weld surface, and the welding rod should be held at an angle of about 75° from the torch or 15° from the work surface as shown in Fig. 3. A steeper angle between rod and work leads to fouling of the electrode.

In the welding of magnesium, stainless steel and Everdur, the filler metal may be added at a rate of speed in inches of rod per minute of from 50 to 100% of the rate of the weld progress. In the welding of aluminum, however, a certain minimum rate of feed must be maintained to prevent the incoming wire from overheating and oxidizing. This minimum rate of rod-feed speed is about 10 to 15 in. per minute. The maximum satisfactory rod-feed rate for all materials is about 35 to 40 in. per minute. By using these rates together with the welding speed and the amount of filler metal required, computations can be made to determine a suitable diameter of welding rod.

Welding rod may be fed by any means that will allow a steady rate of feed, which may be varied to suit conditions. The simplest method for all materials other than aluminum is to lay a length of straight welding rod on the seam. As the torch advances, the rod is melted into the weld. The diameter of the rod is selected to give the desired reinforcement. This method is not satisfactory for welding-wire sizes of less than about 1/16 in. diam., as the force of the arc may blow the rod out of place. Various metal arc rod-feeding mechanisms may be used by reconnecting the electrical circuit so that the rate of feed may be controlled manually rather than as is usual by the arc voltage. It should, of course, be borne in mind that in the inert-gas-shielded arc process the arc voltage bears no relation to the rate of rod feed since the rod is not part of the arc circuit.

Special conditions relating to aluminum should be noted. The proper progress of the weld depends upon cleaning action of the arc on the surfaces to be joined. In hand-welding this occurs through a backward and forward movement of the torch and by dipping the filler rod in the puddle. A satisfactory substitute for this procedure has not been fully developed for aluminum above about 1/4 in. in thickess. While mechanized welds have been made on material as thick as 5/8 in. the operation is slow. For this reason handwelding is recommended on aluminum 5/16 in. and thicker.

Welding Current

The selection of the type of power will depend on the material to be welded. In brief, the requirements are that alternating current is essential for welding aluminum and magnesium. For other materials except on very thin stock (less than 0.040 in.), direct current, straight polarity, is generally found preferable. When direct current, straight polarity, is used in the inert-gas-shielded arc-welding process, the requirements of the generator are

Table 1—Representative Welding Conditions

Material		Edge Preparation	Welding Current		Welding Rate Per Pass, Ipm.	No. of Passes	Filler Rod	A.-C. Wave Characteristic
Type	Thick, In.		Type	Amp.				
Aluminum	0.025	90° FL.	A. c.	75	48	1	No	Unbalanced wave
Aluminum	0.050	30° FL.	A. c.	125	100	1	No	Unbalanced wave
Aluminum	0.064	"	A. c.	130	48	1	No	Unbalanced wave
Aluminum	0.091	"	A. c.	235	48	1	No	Unbalanced wave
Aluminum	0.125	"	A. c.	315	48	1	No	Unbalanced wave
Aluminum	0.125	"	A. c.	390	28	1	No	Balanced wave
Magnesium	1/8	Sq. Butt	A. c.	135	16	1	3/32	Unbalanced wave
Magnesium	1/4	" "	A. c.	435	15	1	3/32	Unbalanced wave
Magnesium	1/2	" "	A. c.	275	8	2	3/16	Unbalanced wave
Stainless steel	0.050	" "	D. c., s. p.	100	40	1	No	.....
Stainless steel	0.062	" "	D. c., s. p.	150	50	1	No	.....
Stainless steel	1/4	Sq. Butt	D. c., s. p.	490	15	1st	3/32	.....
				370	15	2nd	No	.....
Stainless steel	1/4	" "	D. c., s. p.	560	15	1	3/32	.....
Silicon bronze	0.054	Lap	D. c., s. p.	250	26	1	No	.....
Silicon bronze	1/4	Sq. Butt	D. c., s. p.	350	11	1	3/16	.....
Silicon bronze	3/8	" "	D. c., s. p.	510	10	2	3/16	.....
Electric sheet (silicon steel)	0.025	30° FL.	D. c., s. p.	200	180	1	No	.....
Electric sheet (silicon steel)	0.010	" "	D. c., s. p.	150	130	1	No	.....

about the same as for metal arc welding except that in the former the best arc stability is attained at an open-circuit voltage of 50 to 60 v. or higher.

When alternating current is used, however, several characteristics not encountered in other welding methods should be considered. In metal arc welding the electrode coating contains arc stabilizing materials. The lack of any such coating on the electrode in the inert-gas arc process makes it necessary to stabilize the arc in another way. Several methods of doing this have been tried, but the one most widely used is a superimposed high-frequency current. Almost any metal arc welding transformer that has an open-circuit voltage of 75 v. or more may be used. A high-frequency arc stabilizer should be connected in series between the transformer and the arc. The electrical properties of the arc are such that the wave shape may be unbalanced, indicating a flow of current relatively higher during the straight polarity part of the cycle. From a welding standpoint this is desirable since a high ratio of straight to reverse flow gives deeper and narrower penetration than obtainable with a balanced wave. This results in faster welding on lower current demand and less spread of heat in the work, and, as a consequence, less distortion.

Since the wave shape is distorted, accurate measurement of the current is impossible with the usual type of alternating-current ammeter. Furthermore, the degree of distortion or unbalance determines the current required for any particular weld. Since the degree of unbalance depends principally on transformer design and may vary from a completely balanced wave to a condition where the straight-polarity current peak value is three times as much as the reverse polarity current flow, specific current settings for a given size of weld cannot be given.

To illustrate approximate requirements, the conditions in use in several actual operations are listed in Table 1. Since the welding speed will depend on a number of conditions, it is impossible to tell what speed might be obtained without knowing all of the conditions. Table 1 indicates welding rates that have been obtained in specific instances. These are not necessarily the maximum possible welding rates.

Starting the Arc

To realize the maximum advantage of high production through mechanization, automatic starting should be employed for obvious reasons. The method generally used to accomplish this is the use of a high-voltage, high-frequency starting current. Since such a current is used for stabilizing purposes in alternating-current welding, no special equipment other than welding-current control switches are required. Suitably placed limit switches to actuate a primary contactor provide automatic starting and stopping of the weld at the proper time. The sources of the high-frequency current are, of course, connected to the primary contactor.

Automatic starting of direct-current welding is not so easily accomplished as in alternating-current welding. Since high frequency is not needed to stabilize the direct-current, straight-polarity arc, special high-frequency equipment must be provided for starting. Also a greater amount of power is required to ionize the arc gap. For these reasons the spark-gap oscillator type of high-frequency generator having four sets of spark gaps has been found to be much more satisfactory for direct-current starting than the types having only two sets of spark gaps.

When a switch in the exciting circuit is used to break the welding current, the open-circuit voltage of the generator should be established before an attempt is made to start the welding action with high-frequency current. In general, best operation is obtained, both in starting and welding, by using the highest open-circuit voltage available.

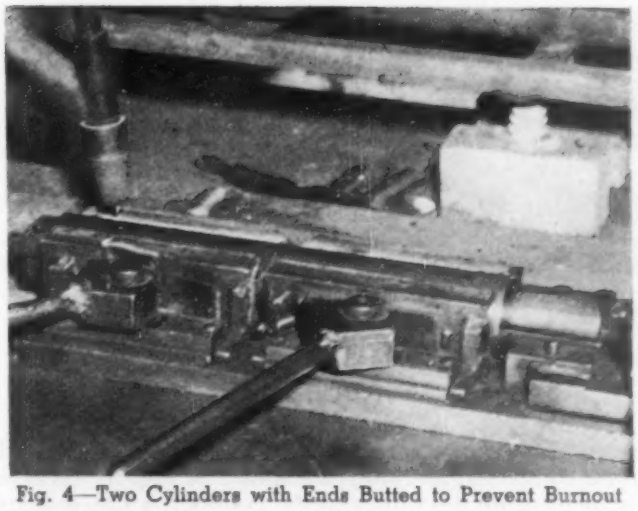


Fig. 4—Two Cylinders with Ends Butted to Prevent Burnout

When mechanical welding is employed for the sake of uniformity and appearance only, and high production is not a factor, the arc may be started by the use of a carbon pencil having an insulated handle. This is accomplished by lightly and momentarily bridging the preset gap between the end of the electrode and the work with the pointed end of the carbon pencil. Care must be used with this method, as the carbon tends to foul the end of the electrode causing it to melt into an enlarged ball. The existence of such an enlargement on the end of the electrode results in wavering of the arc. The electrode must then be ground down to the original diameter to attain arc stability.

Starting and Stopping the Weld Seam

On circumferential seams where the end of the weld overlaps the start, no special precautions are necessary unless conditions are such that crater cracking or porosity become a problem. If this happens, decreasing the current in one or two steps over an inch or less of overlap travel is usually effective. The welding action should always be stopped by breaking the current flow. The weld should not be stopped by raising the torch from the work to break the arc. To do so usually results in crater faults and in marring the workpiece.

As in any welding, seams that start or stop at the edge of sheets being joined require special steps to avoid burnout or notching of the ends of the weld. Where subsequent trimming or welding operations will eliminate a short unwelded section, the weld may be started and terminated just short of the ends of the workpiece.

Where a full, sound weld must be obtained at both extremities of the joint, run-off tabs are required. To obtain uniform results with these, some means of insuring that they are in contact with the workpiece is necessary. This may be accomplished by resistance spot welding or tack welding by hand, or by providing a spring-loaded push-up finger to bear against the end of the tab and thus push it into contact with the work. Where only one end of the weld need be complete, a variation of the end-tab method may be employed. This is accomplished by loading two pieces in the same jig and butting the ends. The weld will then be continuous across the butted ends. An example of this type of

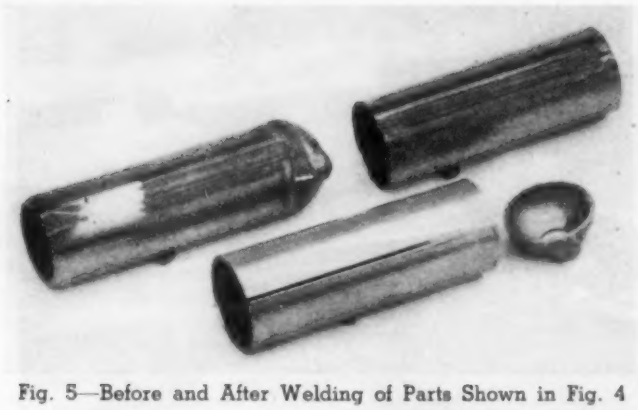


Fig. 5—Before and After Welding of Parts Shown in Fig. 4

operation is shown in Fig. 4. The parts being welded and a completed assembly are shown in Fig. 5. Where the placing of the tabs may be considered too tedious and time-consuming, the ends may be hand welded before or after the remainder of the joint is machine welded.

Welding Jigs

Both longitudinal and circumferential types of joints require holding jigs. The longitudinal types may be either a butt, lap or corner joint, while the circumferential type may be either a butt or a corner joint. With either type of joint the work may be moved under the torch or the torch may be moved over or around the jig and workpiece. The design of the jig will be dictated not only by the size and shape of the work but also by economic balance of the number of pieces to be made against the cost of the jig. Basically, however, the function of the jig is to hold the pieces to be joined in the correct relative positions throughout the length of the joint. They must be strong accurate and hold securely to prevent movement due to expansion and contraction of the workpiece during welding.

For longitudinal seams, probably the simplest and most used construction consists of a length of I-beam on which the pieces to be joined are placed and held by a bar or length of angle iron on each side of the joint. In the simplest form the sheets are clamped by using bolts between the angle irons and the I-beams. More often than not, however, such an arrangement is unsatisfactory. The reason is that the angle irons used as hold-down clamps operate as simple beams and deflection takes place. This results in pressure being exerted on the ends of the work sheets but none throughout the mid-section In use, such an arrangement allows the workpiece edges to move up and down and laterally, and heat extraction from the material varies throughout the length of the weld. The net result is that holes are melted through in the middle of the seam while lack of penetration may occur at the ends. However, in spite of its shortcomings, such an arrangement will be given further consideration for two reasons. First, it is inexpensive and must be used where only one or a few pieces or a size are to be made, and, second, further consideration will serve to illustrate the basic requirements of a welding jig. It was previously stated that the basic function of a jig was to hold the workpiece in correct relative position throughout the length of the joint. To prevent movement of the work in the vertical direction, the following steps may be taken. The hold-down clamps, whether they are of a rectangular section or a rolled structural section, should be bowed slightly. Then , when they are drawn down against the workpiece the pressure is applied first at the midpoint of the length of the clamp. Further, careful tightening of the hold-down bolts will bring the ends of the bars into contact with the work. It will be observed that this operation calls for considerable skill and judgment on the part of the worker. This, of course, can be justified only by the low cost of the arrangement for limited production.

Although care in use of this simple jig will provide proper restraint of the workpiece in the vertical direction, it will generally not be sufficient to prevent movement in the horizontal direction. In horizontal movement, the forces are many times greater than in vertical movement. To provide sufficient force to prevent lateral movement would, especially on long joints, require such deep sections for the hold-down bars as to interfere with accessibility to the joint for welding. Therefore, to prevent the joint from opening during welding it is necessary to tack weld the edges together by hand at intervals throughout the length of the joint. This should be done with the gas-shielded arc process and without addition of welding rod. The weld can then be completed using a torch moved mechanically along the joint. This method is successfully used in joining large sheets of stainless steel in the fabrication of kitchen equipment. It is suitable since the number of joints of one size is limited and because of the low distortion. The underside of the weld is generally used for the finish side of the work as it requires a minimum amount of grinding and polishing.

The above discussion illustrates the major factors in successful jigging in terms of the simplest equipment for limited production. Where the fabrication of large numbers of identical parts is involved more elaborate equipment is justified. This should provide for ease and rapidity of loading and application of pressure without skill on the part of the operator. The use of compressed air to provide the holding force is very desirable. To provide uniform pressure along the length of the hold-down bar, the application of pressure at several points along the bar is indicated. An example of the combination of these features is illustrated in Fig. 6. In this jig the force from air pressure in a length of fire hose is multiplied by levers and applied at several points. The holding power is such as to make tack-welding unnecessary.

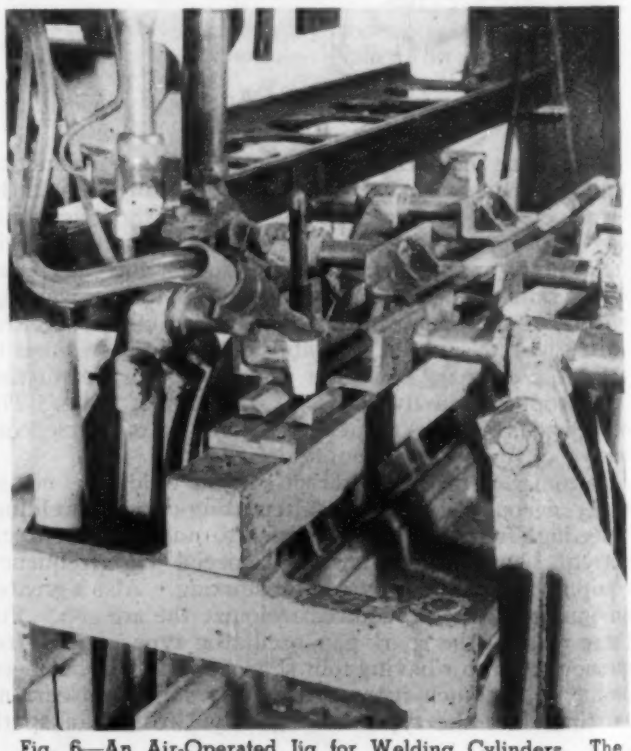


Fig. 6—An Air-Operated Jig for Welding Cylinders. The Backup Bar and Holding Clamps Are Nonmagnetic

So far the discussion has dealt mostly with the requirements for welding of flat or straight seams as represented by the longitudinal seam of a cylinder. The welding of a circumferential seam in a cylindrical or spherical shape involves much the same problems and some not previously covered. To illustrate the operation, consider the fabrication of a beer barrel made of two drawn halves joined in the middle by a girth weld. Here the jig performs its function by doing two things. One is to hold the edges together by applying pressure to the ends of the barrel and the other is to maintain the edges of the sheet level. Figure 7 shows a production line using these jigs.

With a beer barrel there is a large opening in the side into which the bung plate is later fitted. It is possible, therefore, to use an internal collapsible mandrel. By toggle action this mandrel, consisting of two rigid halves hinged together, is expanded against the inside diameter of the barrel. When in place, the mandrel expands the barrel slightly. This levels the edges of the two halves and eliminates any ovalness that might remain in the pieces from the drawing operation. Figure 8 shows such a mandrel being installed.

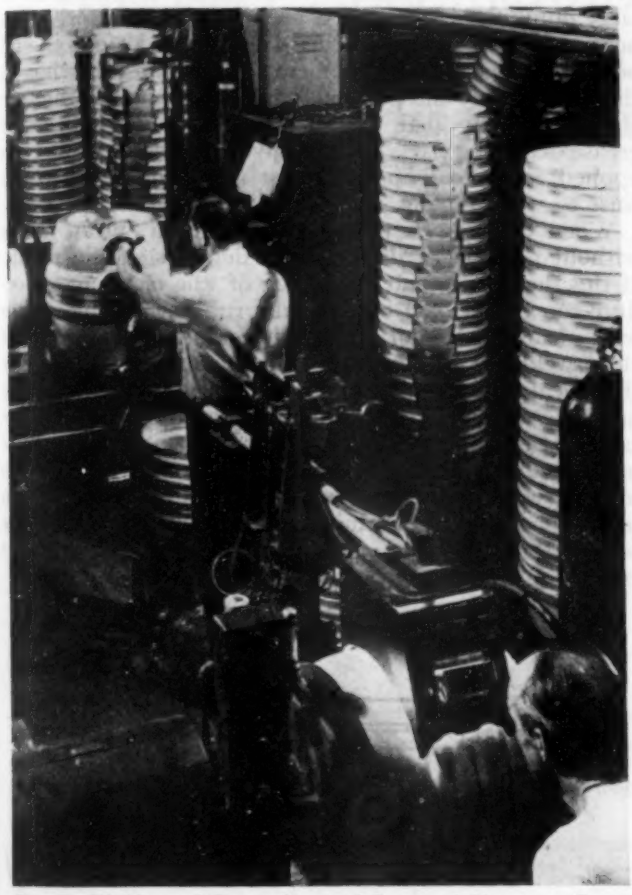


Fig. 7—Welding of Circumferential Seams of Aluminum Beer Barrels

Obviously, a mandrel as described above cannot be used in tanks or vessels not having an opening to allow its removal after completion of the weld. For such vessels, two other procedures are possible. Where the shape of the work permits, as in the welding of a sphere, rigid circular cup-shaped jigs may be provided to fit closely to the weld area. These, by their rigidity overcome ovalness of the parts and, by end pressure, force the mating edges together. Figure 9 illustrates such a jig.

The second method of leveling the edges without the use of an internal mandrel is as follows: Leveling rollers or wheels are rigidly mounted so as to bear on the mating parts as near the weld zone as possible. The position of these rolls must be such as to depress the edges slightly as the barrel revolves beneath the rolls. These rolls are located, one on each side of the seam, just ahead of the welding torch.

Fig. 8—Placing an Expanding Mandrel to Align the Edges of Two Halves of a Barrel

Shape Welding

Circumferential seams in articles having a true circular section can be readily welded by revolving the part under the welding torch. In the fabrication of articles not of circular section, as for instance an ellipsoid, new problems are encountered. Then it is necessary to vary the speed of rotation inversely to the radius of turning in order to maintain the welding rate constant. In addition some means of raising and lowering the welding torch must be provided to maintain the arc length constant. While such arrangements are possible, they require elaborate engineering, and simpler means should be studied.

One such method is available in horizontal shape welding. The simplest variation of this is to weld turned-up

Fig. 9—A Jig for a Thin-Walled Spherical Stainless Steel Vessel

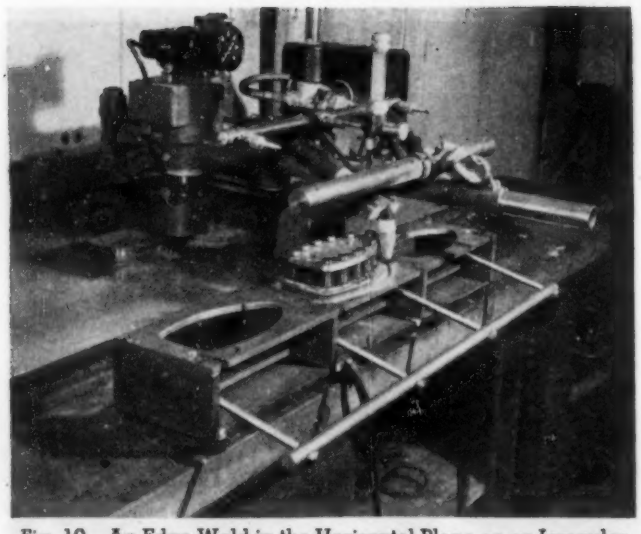


Fig. 10—An Edge Weld in the Horizontal Plane on an Irregular Shape Using a Shape-Tracing Machine

edges, using a standard oxyacetylene templet-tracing shape-cutting machine. An edge weld can be made in the horizontal position using a torch with the electrode held in the vertical position or at 90° to the face of the weld. Here the arc plays from the side rather than from the end of the electrode. Figure 10 illustrates this method in use in the fabrication of an article of irregular elliptical shape. The cutting machine employed here is equipped with a magnetic tracing head. Note that in preparing the templet an allowance must be made for half the electrode diameter plus the arc length.

Weld Backing

Flat backup bars in contact with the edges to be welded are generally unnecessary and undesirable in welding without filler rod. Where backup bars are used as in longitudinal jig welds, the bar should be relieved slightly, usually 0.010 in. or more. The width of this groove should be as wide as the spacing of the top hold-down clamps or approximately ten times the thickness of the material being welded. Under proper welding conditions, the underside of the bead should not touch the surface of the backup bar.

In the welding of stainless steel it is desirable to hold the open space under the weld to a minimum as this reduces or prevents oxidation of the back of the weld. Generally this results in a silvery appearance and little if any sign of oxidation. Hydrogen may be introduced in the backup groove where the maximum in protection is desired.

Where a backing bar cannot be used, three or four closely spaced hydrogen flames may be directed at the underside of the weld. This latter method is sometimes useful in welding closed vessels where free hydrogen would present an explosion hazard. Complete safety from explosion hazard may be attained by substituting an inert gas for hydrogen. The use of special gaseous atmosphere in back of the weld has been found to be of no benefit in welding aluminum or magnesium.

The material being welded will determine the composition of the backup bars. Copper is used with silicon bronze and stainless steel, while steel or stainless steel bars are used with aluminum and magnesium. The various types of backup bars are described further in Fig. 11.

The welding of thicker material using filler rod requires a different treatment of the backup problem. In general the problem and solution here are much the same as encountered in submerged melt welding. When all of the welding is to be completed in one or more passes on one side, a backup bar or shoe is required to support the puddle during the first pass. Where a backing is not feasible, one pass may be made on each side of the plates with conditions adjusted to insure overlap of the two beads.

Cleaning

Cleaning of the material is important and varies with the type of material being welded. Foreign matter on stainless steel and Everdur should be removed. Although it will not particularly harm the progress of the weld, contamination may result. Suitable solvents may be used for removal of grease and oil while scale, if any, may be removed by mechanical or chemical means.

The tendency of aluminum and magnesium to oxidize readily necessitates careful cleaning in order to obtain a smooth welding action. Steel wool for cleaning is usually satisfactory, but chemical treatments may be best if large numbers of small parts are involved. Before magnesium is cleaned, the supplier's recommendations should be consulted, since the treatment will depend somewhat on the type of alloy and previous surface treatment. Before aluminum is welded, degreasing is first used if oil or grease deposits exist. A nitric-hydrofluoric pickle is then applied, followed by a cold water rinse, and a hot water rinse to speed drying.

When cleaning is properly carried out, clean welds without porosity or dark surface deposits should result. If this does not result, efficiency of the cleaning procedure can be checked by carefully rubbing sample pieces with clean steel wool and then welding the pieces. If clean welds are obtained in this manner, then it might be that weak treating solutions, insufficient water flow, or insufficient time of immersion in the water rinse tanks are causing the trouble. Certain degreasing solutions in use today evolve fumes that undergo a chemical change in contact with an open flame. Such action produces a toxic gas and also contaminates the weld. It is therefore essential that the cleaning and welding operations are not carried out in adjacent areas.

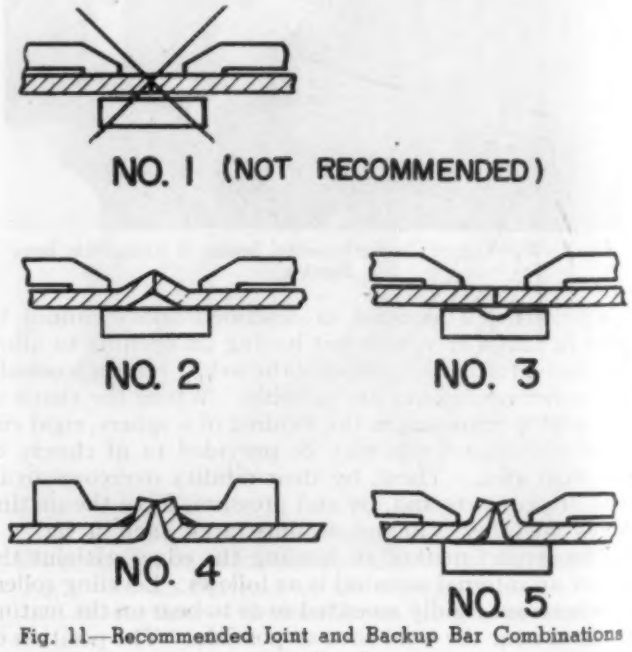


Fig. 11—Recommended Joint and Backup Bar Combinations

Conclusion

The inert-gas-shielded arc-welding process is readily adaptable to mechanization. Some of the advantages to be expected by so doing are: high output per man-hour, high uniformity with average operator skill and low finishing costs. These advantages can, however, be realized only by careful planning, design and construction of the machines to be used. The jigs and fixtures must be accurately and ruggedly constructed to hold the workpiece precisely and to withstand the strain and abuse encountered in operation. Finally, the parts to be welded must be prepared in such manner as to insure a high degree of uniformity.

Proposed Specification for Steel St. L. 37 for Welded Bridge Construction*

By Dr. P. Schoonmaker and Committee

IN 1939 the Netherlands Welding Society formed a weldability committee to study the factors involved in weldability and to formulate a specification. As a result of its work the Committee has written a specification for mild steel for welded bridges with weld factor = 1; that is, the allowable design stress is the same in the weld as in base metal. The tests prescribed are:

1. Tensile test of unwelded plate using the standard Netherlands specimen N712. The required tensile values are:

	Longitudinal	Transverse
Yield point, psi.	Over 31,000	Over 31,000
Tensile strength, psi.	52,500 to 64,000	52,500 to 64,000
Elongation in 5 diam.	Over 27%	Over 22%

2. Bend test of unwelded plate using the standard Netherlands specimen N713. The requirements are 180° bend for a longitudinal specimen.

3. Notch impact tests of unwelded plates using specimens 10 x 10 x 55 mm. with round notch, 1 mm. radius, 3 mm. deep. In all tests the notch is perpendicular to the surface of the plate. The requirements are shown in Table 1.

4. Bead-bend test for plates over $^3/_4$ inch thick. This test is a required method of inspection but the results are intended for information only. A round groove 3 mm deep, 9 mm wide is machined in the surface of the plate. A weld bead is deposited in the groove at 200 amperes with an electrode 5 mm. diameter (0.20 inch).

The steel of this specification must be killed open-hearth steel meeting the limits of chemical composition shown in Table 2.

Table 1—Notch Impact Test Requirements in Meter Kilograms per Sq. Cm.

Plate Thickness, In.	Specimen Location	Longitudinal: Average of Five Tests	Longitudinal: Minimum	Transverse: Average of Five Tests	Transverse: Minimum
Less than $^3/_4$	Surface of plate	10	8	7	5
Over $^3/_4$	Surface of plate	10	8	7	5
Over $^3/_4$	Center of plate thickness	8	6	.	.

Table 2—Composition of Weldable Steel St. L. 37

	For Plates Less Than $^3/_4$ In. Thick; Average Over the Entire thickness. For Plates Over $^3/_4$ In. Thick, Average of the Surface Zone	For Plates Over $^3/_4$ In. Thick, Average of the Mid-Thickness
Carbon, %	0.17 max.	0.17 max.
Manganese, %	0.35–0.65	0.35–0.65
Silicon, %	0.05 min.	0.10 min.
Phosphorus, %	0.06 max.	0.06 max.
Sulfur, %	0.04 max.	0.05 max.

The silicon content of killed steel normally is 0.08–0.15%, but it is realized that steel can be killed with aluminum or other elements. The allowable sulphur content, from the standpoint of weldability, depends on its distribution. Consequently it is desirable to sulphur print the plate. It would be desirable to limit the nitrogen content of the steel, but this is not practicable at present.

Killed steel is specified for the following reasons: (*a*) uniformity of composition, (*b*) absence of segregated core zone, (*c*) small variation in properties from surface to center of thick plates and sections, (*d*) high notch toughness at low temperatures, (*e*) low sensitivity to aging.

The Committee realizes that the problem of weldability has not yet been solved completely, and have not prescribed tests for sensitivity to aging and tendency to brittle fracture. These subjects are being given further study.

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* Translation of *Voorsteel Keuringseisen voor Staal St.L. 37 voor gelaste Brugconstructies*, published in Laschtechniek, vol. 13, pp. 93–94 (Oct. 1947). Translated by G. E. Claussen, Chief Metallurgist, Reid-Avery Co.

The Uses of Flux-Injection Cutting for Stainless Steels*

By G. E. Bellew†

THE stainless steels, both straight chromium and chrome-nickel types, resisted the oxyacetylene cutting torch for many years. During the past two years, however, the development of flux-injection cutting, a simple, economical and effective method, has overcome the difficulty. Now, where flux-injection is in use, stainless is being cut and shaped by the torch for the first time with costs and quality comparable to mild-steel cutting.

The fundamental difficulty in flame-cutting stainless steels by regular methods is a layer of refractory oxides, principally chromium oxides. These oxides have such high melting points that they do not liquefy and flow off as slag in the way mild steel oxides do. In flux-injection cutting, a chemical flux is used to permit fluid slagging of these oxides, which would otherwise block the cut.

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Fig. 1—The Flux Feeder Unit, Compact and Portable, Is the Key to the Flux-Injection Process. Controls Are Simple—a Variable Dial Setting for Flux Flow, and an On-Off Switch. There Is Also a Remote On-Off Control Receptacle, and a Pilot Light

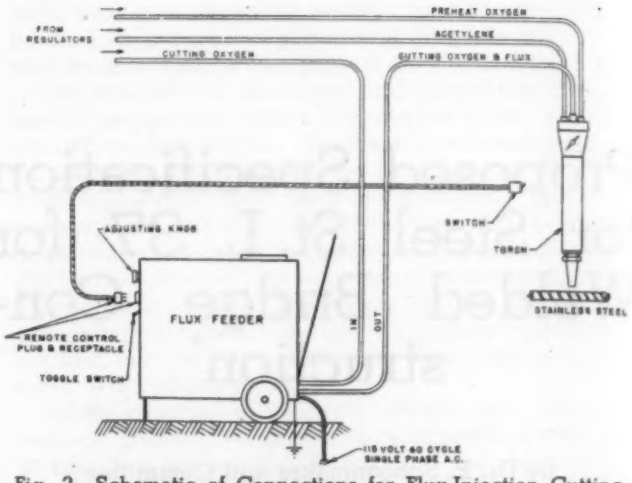

Fig. 2—Schematic of Connections for Flux-Injection Cutting Shows How Flux Feeder Unit Is Coupled Into Cutting Oxygen Line, with All Other Connections and Equipment Conventional, Which Minimizes the Difficulty of Switching Over to Ordinary Mild Steel Work on the Same Equipment Setup

The flux is a finely pulverized nonmetallic material, of reasonable cost. The means of applying it is simple and efficient, requiring only one compact piece of special equipment—the flux feeder unit (Fig. 1). The key operating element of the flux feeder unit is a pressurized vibratory hopper, which is coupled into the cutting oxygen line (Fig. 2). Depending on the requirements of the job, the unit feeds flux to the cutting oxygen line at a selected rate. The flux is carried directly by the cutting oxygen itself, and emerged from the cutting orifice of the tip (Fig. 3) so that cutting and fluxing action are both obtained in the kerf at the same time. As fast as the oxides from cutting form, they slag off, and a fresh surface of metal is continuously exposed to the cutting oxygen.

Except for the flux feeder unit, the equipment for flux-injection machine cutting is little different from that used for mild steel work (Fig 4). Three-hose torches of standard type are used, since the flux is only desirable in the cutting oxygen and not in the preheat. Tips of standard design are used, usually with rather heavy preheat and six preheat orifices. Otherwise, the usual machine cutting equipment completes the setup. For hand work, a three-hose hand torch has been developed, incorporating a combined oxygen valve and remote flux feeder switch for simultaneous starting of cutting oxygen and flux flow. This torch also uses standard tips and other accessories.

Most standard processes require modification when applied to stainless steels, and flame cutting is no exception. The addition of the flux adds another variable to the operation; speeds and pressures vary somewhat from

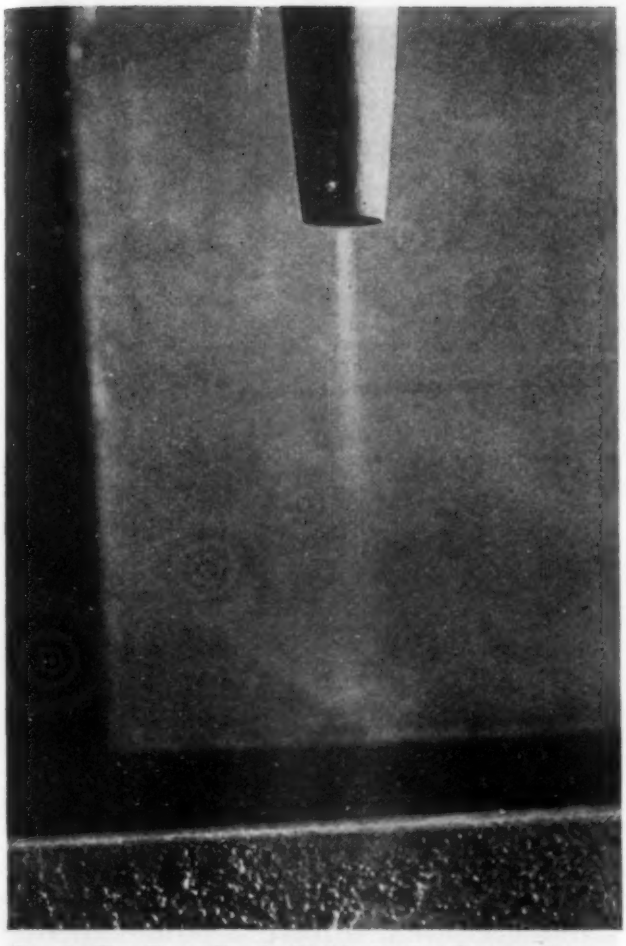

Fig. 3—The Flux, Clearly Visible in the Oxygen Stream, Emerges from the Cutting Orifice of a Standard Tip

mild steel practice; and as with other processes when used on stainless, the operation as a whole is somewhat more critical.

The temperatures involved in flame cutting naturally raise the problem of carbide precipitation, just as do the temperatures in welding these materials. As short a time as 2 or 3 min. in the temperature range between 800 and 1600° F. may cause the formation of chromium carbides between the grains of the steel, and result in a loss of corrosion resistance in the affected area. Generally,

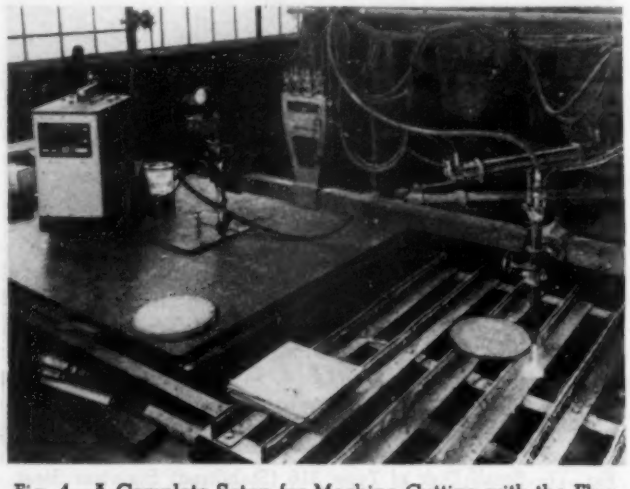

Fig. 4—A Complete Setup for Machine Cutting with the Flux-Injection Method Differs in Appearance from Standard Equipment Only by the Inclusion of the Flux Feeder Unit. In This Instance, Disks Are Being Produced from Type 316 Plate in a Large Warehouse

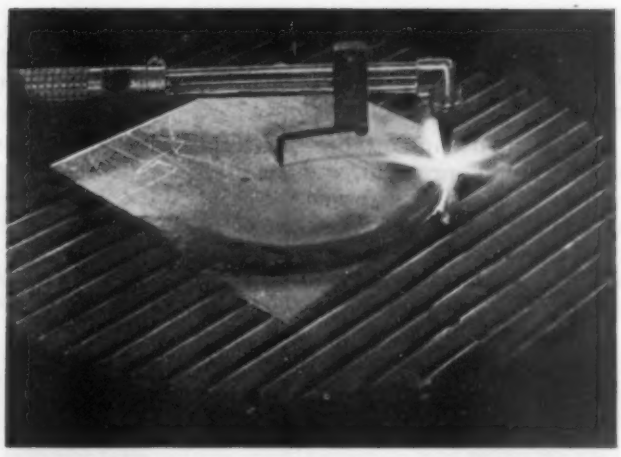

Fig. 5—Disks Similar to Those in Fig. 4 Are Cut with a Field-Trial Model Flux-Injection Hand Torch, Which Is Equipped with a Third Hose for the Cutting-Oxygen-and-Flux Stream, and a Built-in Remote Control for the Flux Feeder Unit Which Is Actuated by the Cutting Oxygen Lever

measures similar to those used in stainless welding procedures will meet the difficulties arising from the heat involved in flame cutting. In actual practice, however, each instance should be considered separately, in the light of specific factors affecting it, and if necessary, checked with a qualified authority. There are many variables involved—the end use of the material, for instance—and others too numerous to catalog. There are, however, a few general guides which may be used with reliability in dealing with the problem:

The stabilized types—321, stabilized with titanium, or 347, stabilized with columbium, are not affected.

Unstabilized materials of very low carbon content will be affected only sightly, if at all.

Where the work can be heat treated to 1950° F., with a rapid quench, the carbide zone will be eliminated by that operation.

When finish machining is required on the cut edge, tolerance of the cut can be adjusted so that the very narrow area of affected metal will be removed.

When the cut edge is to be welded, the heat effects of welding will supersede those of flame cutting, and sound welding design will have provided for them.

Fig. 6—Cutting Large Disks from Stainless Plate with Flux-Injection and Standard Radiograph. Fourteen Disks Were Produced by Flux-Injection in the Time Required to Cut Four by Machining. Machining Also Required Five Crane Lifts per Disk; Flux-Injection Cutting, One

In other cases, the heat effect can be at least held to a minimum by providing a means to bring the metal out of the danger zone rapidly, before carbide precipitation can proceed to a troublesome extent.

While the use of stabilized material is by far the best solution to the problem, and the additional cost of such material can easily be absorbed by the savings from flame cutting, proper attention to choice of material and procedures will usually overcome the problem even when stabilized material is either undesirable or not available.

Practically every possible application of stainless steel

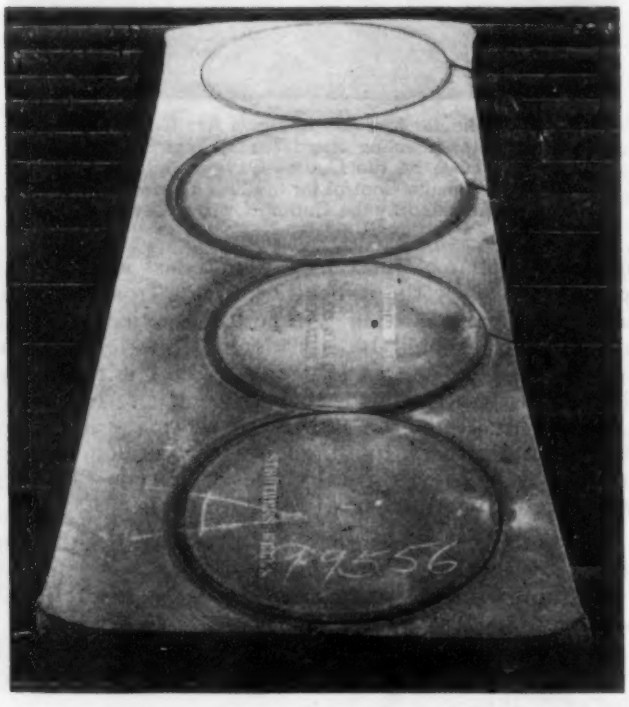

Fig. 7—Finished Cuts on Disks of Fig. 6 Show Clean, Even Kerfs, and Smooth Contours, Characteristic of Good Flame-Cutting Work. The Parts Are Ready for Welding Into Plate as Heads in Pressure Vessels. The Sizable Pieces of Scrap Left After Flame Cutting the Disks (Figs. 6 and 7) Are Usable for Smaller Parts, but Would Have Been Reduced to Chips and Shavings on the Boring Mill Used Previously to Produce These Parts

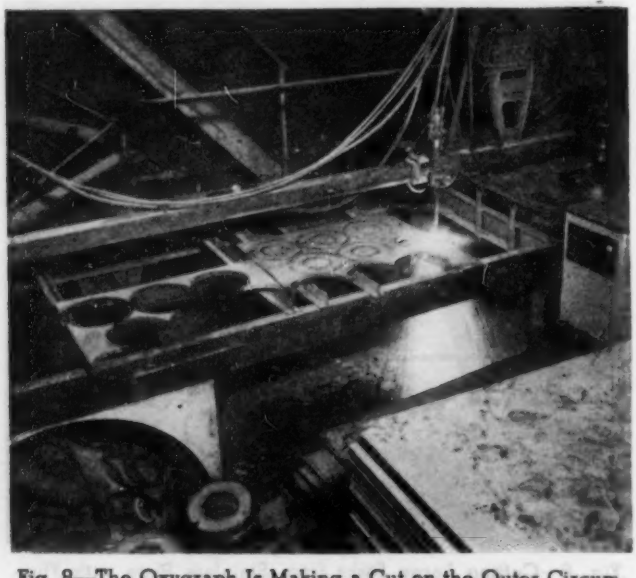

Fig. 8—The Oxygraph Is Making a Cut on the Outer Circumference of a Ring, After Removing the Inner Circle. Interfitting in the Layout of These Parts Has Eliminated Considerable Scrap Between the Circles, and Increased the Number of Parts Obtained from a Given Area of Plate

Fig. 9—Rings (Fig. 8) Are Machines, After Cutting by Flux-Injection on Face and Inner Circumference, But Flame-Cut Surface is Quite Satisfactory for Outer Edge. Roughing Out Inner Circumferences with Flux-Injection Cutting Saves Costly Machining Time

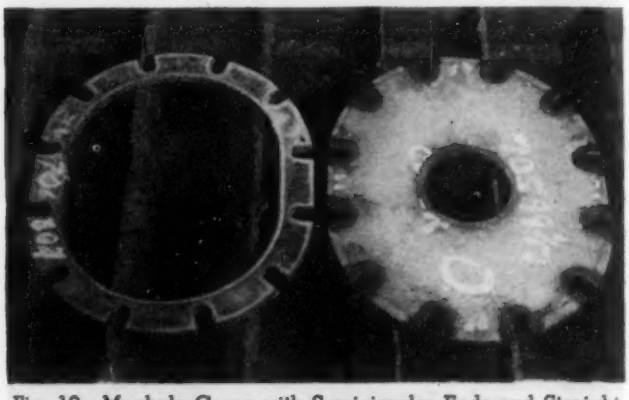

Fig. 10—Manhole Cover with Semicircular Ends and Straight Sides Is Finish Cut by Flux-Injection from Type 347 Stabilized Stainless Plate. Outer Contour Cut Is Nearing Completion Here, and Will Be Followed by Cutting Out Bolt Slots in Edge, and Circular Center Hole. Manhole Cover and Matching Flange, Cut Entirely by Flux-Injection, Ready for Installation on the Final Assembly. Because Stabilized Material Was Used, Danger of Loss of Corrosion Resistance in the Stainless Was Eliminated

Fig. 11—Small Disk of Type 316 (Stabilized) Stainless Steel, $^{5}/_{16}$ In. Thick, Being Cut with Flux-Injection on a Travograph (See Fig. 4) in a Large Steel Warehouse. In This Case, Flame Cutting Stainless Is Not Only Speedy and Economical, But Makes Possible Filling Such Orders Without Investment in Costly Machining Equipment

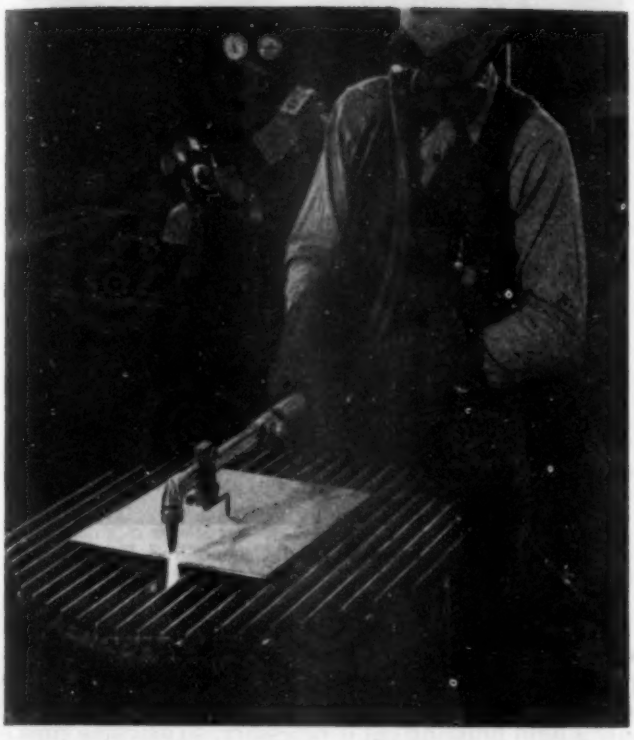

Fig. 12—Disk, Similar to Fig. 11, Is Here Cut by Test Model Hand Torch and Center-Point Device. In This Case, However, the Center Will Also Be Removed to Form a Ring, and the Starting Hole for the Inner Cut Has Already Been Drilled

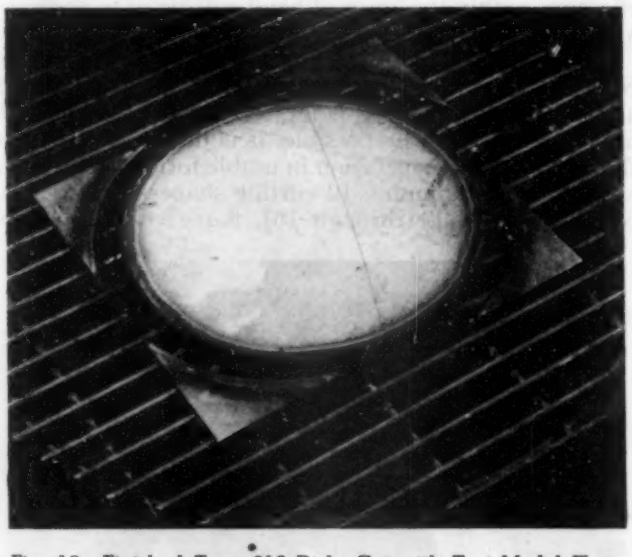

Fig. 13—Finished Type 316 Disk, Cut with Test Model Flux-Injection Hand Torch, Shows Good Contour and Clean Edge Which Compare Favorably with Hand Cutting on Mild Steel Work

flame cutting has been handled successfully, at least on a full-scale test basis. Ingots more than 2 ft. thick have been cropped, sliced and scrapped in the mill. Slabs can be ripped to rerolling sizes. Plate of almost any thickness can be cut to accurate size and shape. Risers can be removed from stainless castings. Stack cutting of thin material and light plate, in both stainless and mild steel, has been accomplished with far less clamping than in conventional stack-cutting practice. As stainless steel supplies get easier, and more know-how is acquired in the techniques of handling flux-injection cutting of the various alloys, the process is becoming common practice.

One type of part for which flame cutting is most valuable is circular units—rings, disks, flanges, etc. Such pieces are produced in sizes ranging from a few inches in diameter up to several feet (Figs. 6 through 13). They were previously produced, slowly and at high cost, on machine tools such as boring mills. To perform such

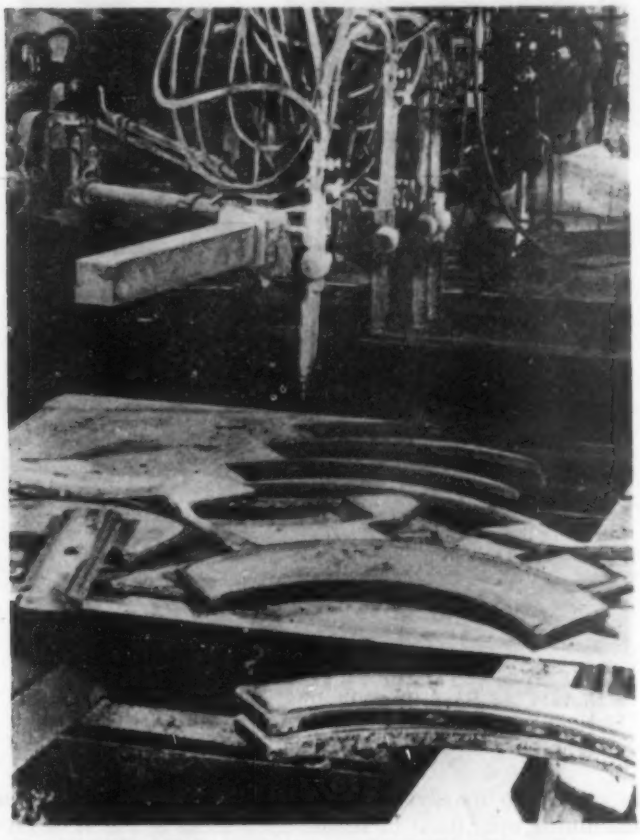

Fig. 14—Scrap-Reducing Practices of Mild Steel Flame Cutting Are Here Applied to a Stainless Steel Flux-Injection Cutting Job, by Nesting the Shapes. Plate Is 5/8-In. Type 304, and While the Flux Feeder Unit, Right Background, Is an Experimental Model, It Is Essentially the Same as the Production Model (Fig. 1). Sixteen Pieces were Obtained from the Plate, Each Involving About 55 In. of Cutting. This Represents Considerably More Production Than Could Have Been Achieved from the Same Area by Machining Methods, and Much Less Scrap Loss. 1/4 In. All Around Was Left for Finish Machining

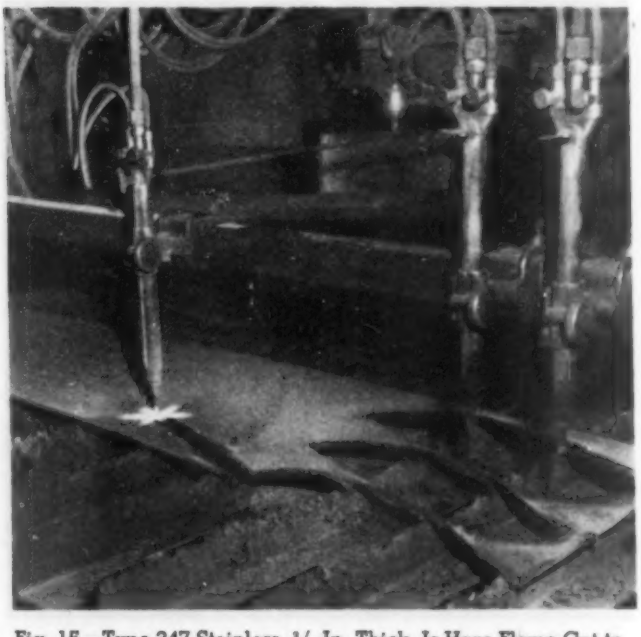

Fig. 15—Type 347 Stainless, 3/8 In. Thick, Is Here Flame Cut to Finish Dimension with Flux-Injection on a Standard Oxygraph to Form Vanes for a Paper-Making Machine

Fig. 16—Welding a Stainless Vane Into the Flanged Portion of a Nickel-Clad Head (Figs. 14–15). The Clean Quality of the Straight Edge of the Vane, in the As-Cut Condition, Is Readily Apparent

an operation involves first cutting a square, which is a machining operation in itself, then making the slow circular cut. This method requires considerable handling of the material, much machine time, labor cost and also waste of material, for little if any useful scrap remains after such operations.

Flame cutting obviously eliminates most of these draw backs. Applications of flux-injection cutting to such units have resulted in savings as high as four or five to one, plus the saving of a sizable amount of useful scrap

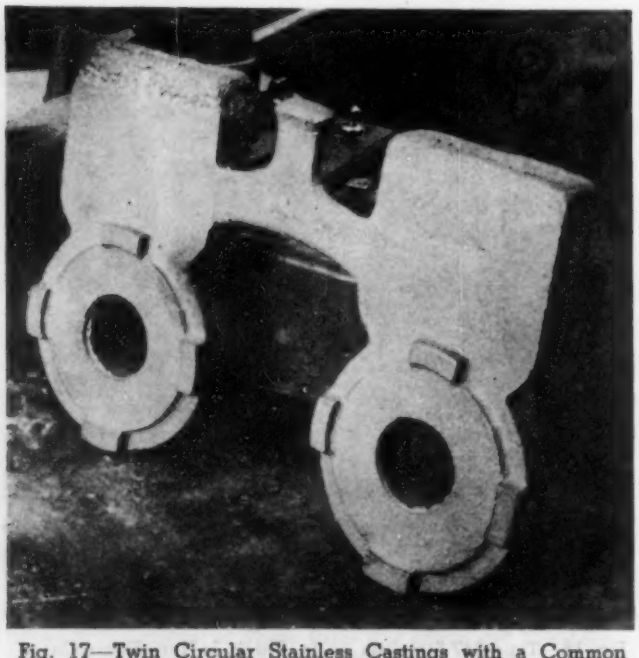

Fig. 17—Twin Circular Stainless Castings with a Common Riser to Be Removed. Cut Is to Be Made on a Circular Line Concentric with the Shape of Each Casting

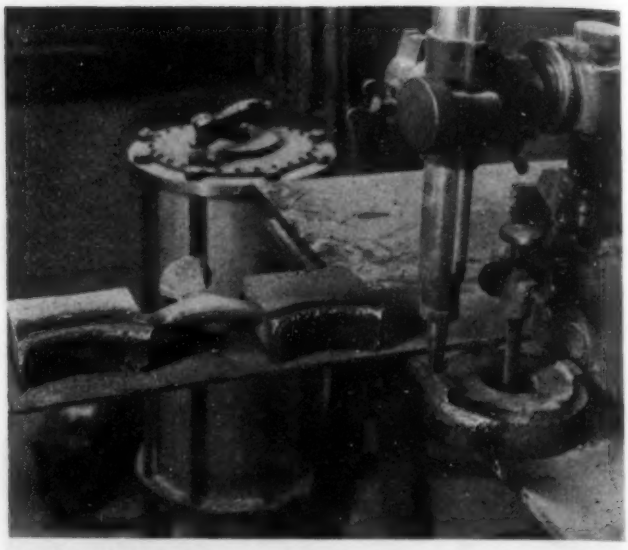

Fig. 18—Finished Cuts on Round Casting and Risers Show Flat, Even Pad, Close to the Line, Which Will Require a Minimum of Grinding to Finish

which is left intact. Even when machine finishing is required on the cut edges, flame cutting offers valuable savings. The torch then serves as a roughing tool, and only a light finishing cut is necessary, so machine time is sharply reduced. While portable cutting machines such as the Radiagraph are probably the most suitable means for cutting such circular parts, tracer-type shape cutting machines have also been used, and hand work is also effective, within the limits of hand cutting as to accuracy and quality.

In working with stainless steels, saving of material becomes a really important goal. The alloys are expensive, and their value as scrap is far out of proportion to the first cost. Whenever possible, it is desirable to obtain the waste from an operation in usable form, or hold it to an absolute minimum. In cutting shapes and irregular contours (Figs. 14 through 16), flame cutting can be

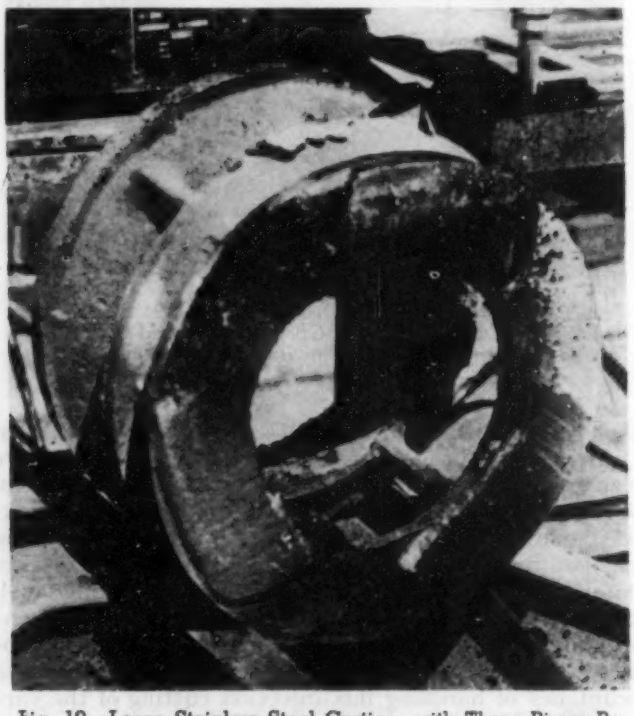

Fig. 19—Large Stainless Steel Casting, with Three Risers Removed by Flux-Injection Cutting, Shows Flat, Even Pads, Requiring Minimum Grinding, Which Are Characteristic of Machine Flame Cutting in Riser Removal

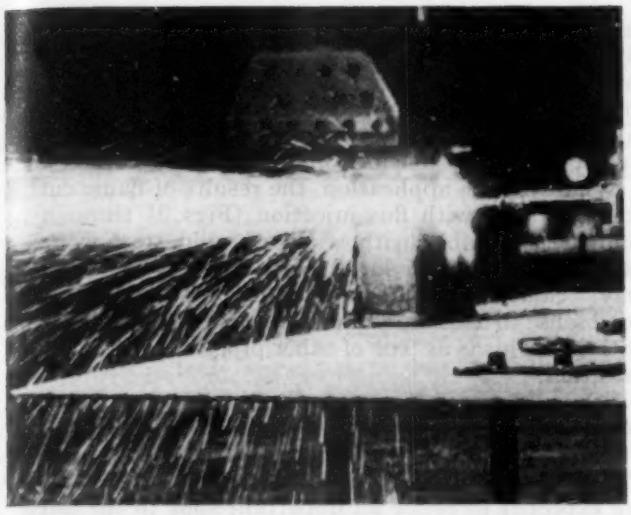

Fig. 20—Test Made on a Scrap Stainless Steel Riser Proves Feasibility of Horizontal Cutting in Such Applications. Speeds and Quality Were Consistent with Those Obtained in Vertical Cuts on Same Test Sample

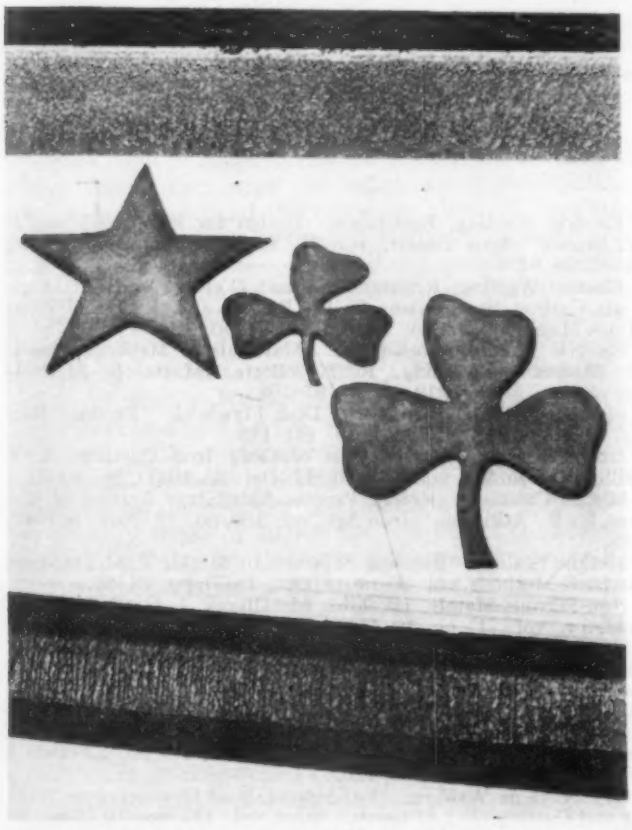

Fig. 21—Test Pieces Cut with Flux-Injection to Indicate Its Versatility and the Quality of the Results in Heavy Material. Top and Bottom Samples Cut from Heavy Plate Show Characteristic Smoothness, and Intersection of Bevel and Straight Cuts in Bottom Sample Indicate Degree of Cut Control Possible with the Method

especially economical, for by interfitting and nesting of the shapes, or by skillful layout work where the shapes are unsuited to nesting, practically the entire area of a plate can be made to provide useful material.

While the bulk of stainless plate runs to thicknesses under 1 in. which puts most flux-injection cutting applications in that thickness range, the process is equally successful on heavier material. In one large steel mill, slabs 3 to 5 in. thick are cut regularly. Cuts are made lengthwise and crosswise on these slabs to reduce them to sizes for rerolling into thin plate and sheet. In the same mill, ingots up to $2^1/_2$ ft. thick have been split for metallurgical testing, cropped and sliced to suitable size for use as furnace scrap. After suitable operating procedures for such heavy material were worked out, little difficulty was met in these operations.

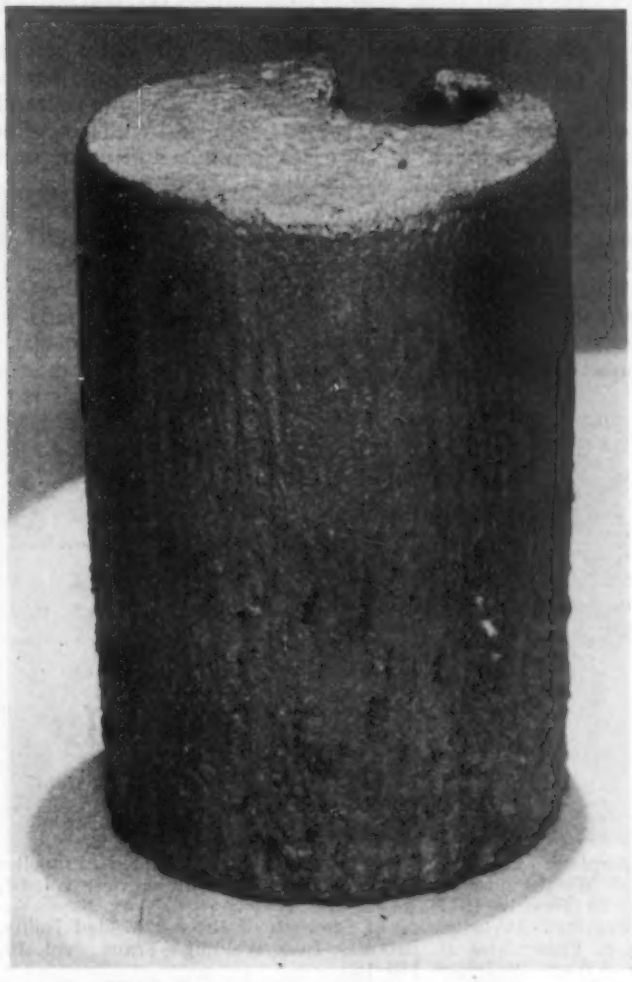

Fig. 22—Plug, Flux-Injection Cut from $3^7/_8$-In. Plate, Further Demonstrates the Quality of the Results with the Process

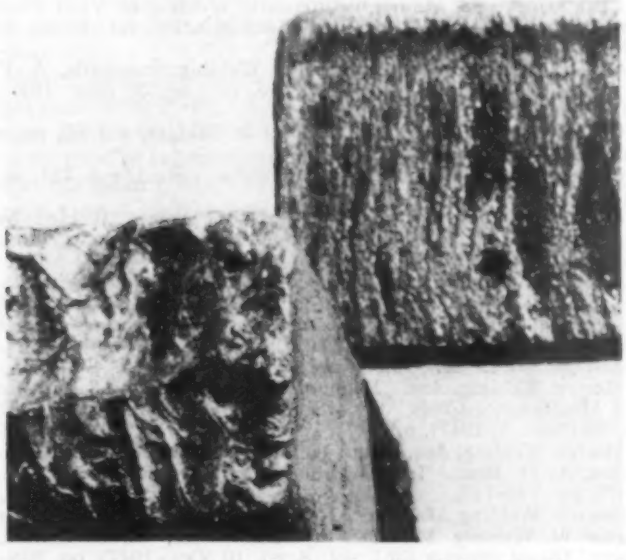

Fig. 23—Comparison of a Carbon Arc Cut, Left, and a Vertical Flux-Injection Cut, Right, on the Same Type 316 Riser. The Flux-Injection Cut Is Flat and Even, While the Carbon Arc Cut, in Which the Metal Is Melted Away, Varies from a Flat Plane by Over an Inch

Similarly, the removal of risers from stainless steel castings (Figs. 17 through 20) often requires cutting thicknesses greater than those found in the run of plate work. The need for an effective flame-cutting method for stainless was probably more sharply felt in the foundry than in any other field. Risers, however, can now be removed readily and neatly, just as mild steel risers are, with flux-injection cutting. Such work can even be put on a production basis with machine setups if quantities of identical castings warrant that step. Even with hand torch methods, however, the flat thin pad which results from flame removal of the riser minimizes grinding and creates savings all down the line. The flame cut is rapid and can be accurately controlled. The body of the casting is protected from gouges, and the torch is by far the most flexible tool for the job.

There is one point, however, which creates difficulties in flame cutting stainless risers— the design of the riser itself. Many, if not most, such risers are designed with round corners and curved sides. Such a shape makes starting the cut much more difficult than it should be. By redesign to get at least one square corner on the riser, or by mechanical nicking of the riser before cutting, the difficulty can be overcome. In any case, the economic advantages of flame cutting the risers from the castings justify any reasonable measure to make the method work.

Whatever the application, the results of flame cutting stainless steel with flux-injection (Figs 21 through 23) compare favorably with standard mild steel work—as long as the operator knows and does his job the right way. Stainless is an expensive material, and it is only good sense to use the best available operators in any work with it. This is as true of other processes as it is of flux-injection.

While flux-injection as yet has hardly begun to fill its potential range of possible applications, it has been put to ample use to prove its worth as a production process. The economies and operating advantages of the process are expected to prove an important spur to the already rapid expansion of stainless steel uses.

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Arc-Welding Copper Vessels*

By J. J. Vreeland†

COPPER, a truly ancient metal, has been used since time immemorial as a corrosion-resistant container for liquids, particularly water. The development of special alloys in the ferrous field as well as the nonferrous field, has curtailed the use of this red metal for various reasons. Structurally, copper cannot compete with some of the high-strength alloys now commercially available but the main contributing factor in the gradual disappearance of this metal has been the slow development of modern methods of fabricating by welding. Ancient coppersmithing methods cannot compete with modern arc-welding methods now being used for the fabrication of other materials. Considerable advancement has been made but there is still need for further development to insure the metal a competitive industrial field.

In the design of copper pressure vessels, the method of welding fabrication must be taken into consideration. For safe shell and head thickness, an allowable working stress of 6000 psi. must be used in design of annealed copper vessels, or all copper vessels if oxyacetylene welding methods are to be used. It is unfortunate that the yield strength‡ of this material is only 10,000 psi. with a tensile strength of 30,000 psi. Cold rolling increases the yield strength at a much greater rate than the rate of increase of tensile strength. Cold rolling reduction of 5–7% increases the yield strength to approximately 25,000 psi. with a tensile strength of approximately 35,000 psi. Because of this elevated yield strength, shell and head thickness can be calculated using an allowable working stress of 10,000 psi. A vessel so designed must be fabricated by the carbon arc welding process or by some process where a limited amount of annealing of the copper occurs during fabrication.

The relationship between allowable working pressure and test pressure is of vital importance to minimize distortion of the unit at test pressures. Test pressures for annealed copper vessels should not exceed $1^1/_2$ times the allowable working pressure. This also applies to vessels fabricated from cold-rolled copper but fabricated by the oxyacetylene method. Vessels fabricated using cold-rolled copper and carbon arc welded should not be tested at pressures exceeding $2^1/_3$ times the allowable working pressure. If test pressures greater than these indicated are to be used, then the design must be made using a higher allowable working pressure. Using material as ductile as copper, a test pressure $1^1/_2$ times the allowable working pressure assures a safe tank in service, particularly if the tank is equipped with safety valves.

Small copper vessels, such as water heaters and household storage tanks, are usually fabricated in sufficient quantities to warrant the cost of proper hold-down and back-up jigging (Fig. 1) to speed up and facilitate the welding fabrication. Since these types of vessels are highly competitive, it is recommended that cold-rolled deoxidized copper be used. Using 10,000 psi. allowable working stress and an arc method of welding, a satisfactory, competitive tank is obtained that can be tested at pressures approximately $2^1/_3$ times the allowable working pressure. The size of vessel manufactured according to these recommendations is limited by the sheet sizes of deoxidized copper that can be given a light cold-rolled finish.

Fig. 1—Hold-down and Back-up Assembly for Production Welding of Copper Tank Shells and Cylinders (Clamping Device)

Large vessels requiring plate sizes of deoxidized copper that cannot be given a light cold-rolled finish are designed using 6000 psi. allowable working stress. An arc-welding method of fabrication would be recommenced to minimize the labor cost of fabrication. Such a tank would be limited to a test pressure of $1^1/_2$ times the allowable working pressure.

Unfired pressure vessels can be constructed to meet the A.S.M.E. Code using the above recommendations. Annealed deoxidized copper only can be used and the test pressure would be $1^1/_2$ times the working pressure. Arc welding or oxyacetylene welding would be used and the procedure qualified by demonstrating the results obtainable with procedure and welder qualification tests.

Welding Methods

Oxyacetylene Welding

Oxyacetylene welding of deoxidized copper has been used for a number of years in the fabrication of all types of copper equipment. Various welding rods are avail-

* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

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‡ Yield strength is taken at 0.5% extension under load.

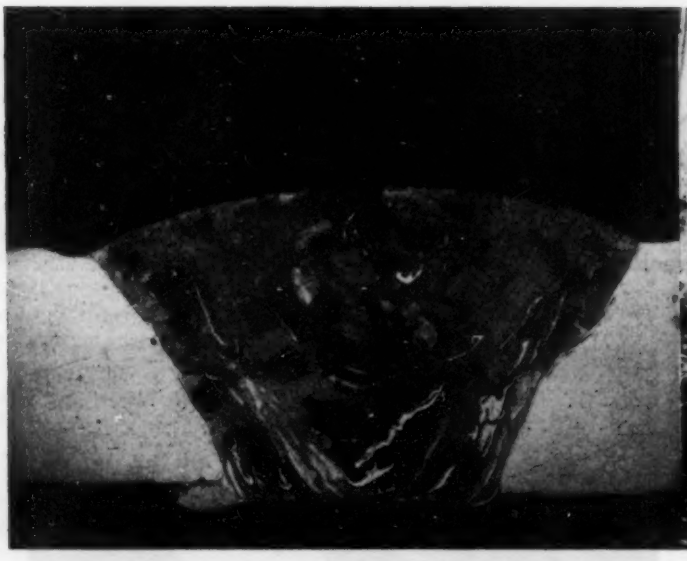


Fig. 2—General Structure—Carbon Arc Weld $^{3}/_{16}$-In. Thick Deoxidized Copper. Copper Silicon Alloy Welding Rod Used. Magnification, × 5

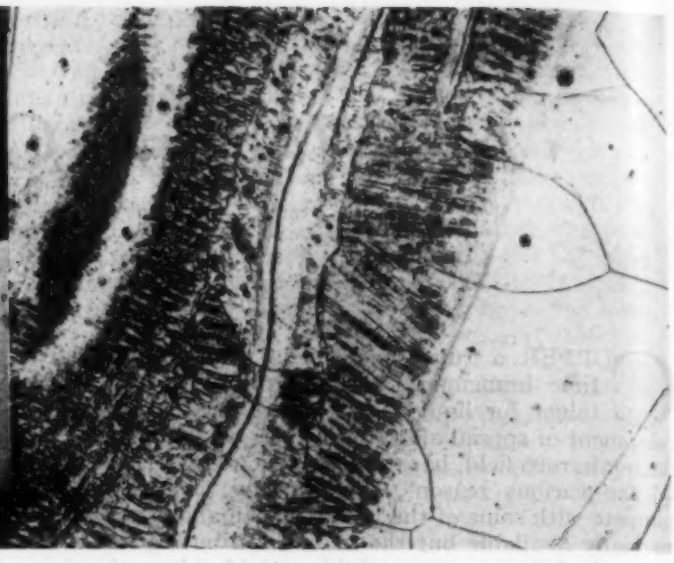


Fig. 3—Structure at Bond of Weld in Fig. 2. Note Density of Weld Metal and Intragranular Bonding. Magnification × 75

able for this work with tensile strengths obtainable in the joint approximating 90% of the minimum tensile strength of the deoxidized copper. The yield strength of the copper adjacent to the weld, however, may be reduced to a value approximating 7000 psi. This lower yield strength would permit distortion under test pressures which are $1^{1}/_{2}$ to 2 times the working pressure. Cold working of the area adjacent to the weld is quite often used to compensate for the abnormal lowering of the yield strength during welding. High labor cost in this type of welding is forcing the purchaser to consider other materials that can be fabricated at lower costs.

Fig. 4—Method of Plate Setup for Welder Qualification or Procedure Qualification. Note Grooved Copper Back-up and Hold-down Bars Clamped to Prevent Lifting of Copper During Welding. Flux Being Applied Prior to Welding

Carbon Arc Welding

The carbon arc welding method has proved its flexibility and low cost in the fabrication of silicon bronzes. Lineal welding speeds of 10–20 in. per minute and preheating temperatures of only 400° F. definitely indicate considerable saving in labor as compared with oxyacetylene welding. Jigging and backing up the joint is of prime importance and the added cost for this is offset by the low cost of welding.

High heat input is required to compensate for the high thermal conductivity of the deoxidized copper. Because of the high heats involved, some method of backing up the weld metal must be used to prevent melting through. This is best accomplished by beveling and rolling the copper plates so as to have the weld groove on the inside of the shell. The root of the joint is placed on a flat copper bar (Fig. 8) and the shell supported to prevent collapsing. If the shell is small in diameter, the plates are beveled and rolled so as to have the weld groove on the outside of the shell. A back-up bar is then held

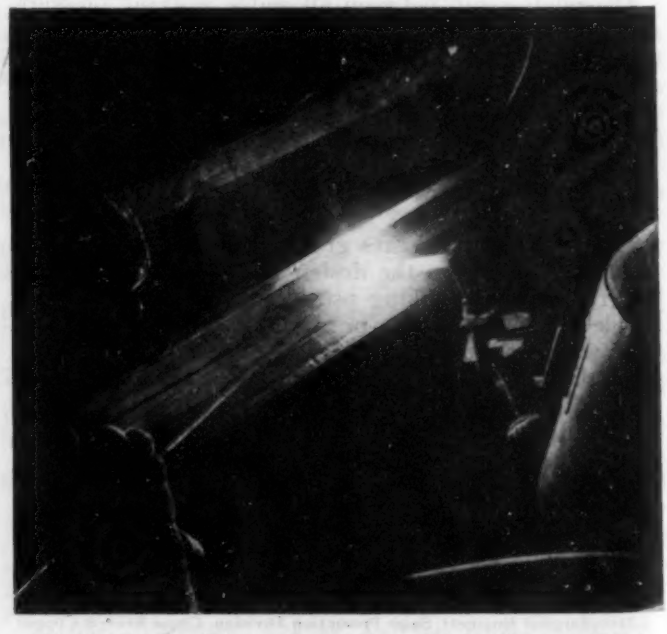


Fig. 5—Welding (Carbon Arc) of Copper Plates Shown in Fig. 4

in position against the root of the joint after the shell has been securely tack welded. Hold-down and back-up assemblies are often used for production welding (Fig 1).

For maximum flexibility, density of weld metal, control of weld metal and multiple bead welding, copper silicon alloy welding rod containing 3% silicon and a properly designed flux should be used. All thicknesses of copper $^{3}/_{16}$ to $^{3}/_{4}$ in. should be beveled to form a 90° groove angle with no root face to minimize heat input and to minimize copper base metal disturbance. A root opening of $^{1}/_{16}$ to $^{3}/_{32}$ in. should also be used to further minimize heat input and to obtain complete fusion at the root edge. Lack of fusion at the root edge or the use of a root face will lead to porosity in the weld metal at the root of the weld. Thicknesses of copper $^{3}/_{4}$ to $1^{1}/_{8}$ in., inclusive, should be beveled to form a 75° groove angle with no root face. Over $1^{1}/_{8}$ in. thick carbon arc welding is not practical because of the necessity of making a double V-groove weld. Table 1 shows the approximate welding machine settings, welding rod sized, etc. for successful carbon arc welding of deoxidized copper. Fig-

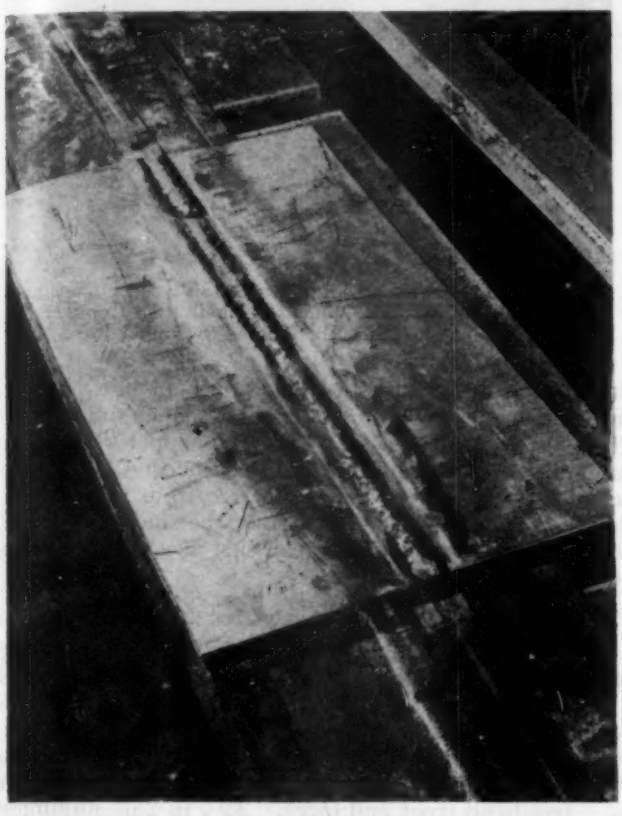


Fig. 6—Bead Appearance of Completed Joint Being Welded in Fig. 5

Fig. 7—Bottom Side of Plates Welded in Fig. 6. Note Reinforcing Bead on Underside Due to Penetration of Weld Metal into Groove in Copper Back-up Bar

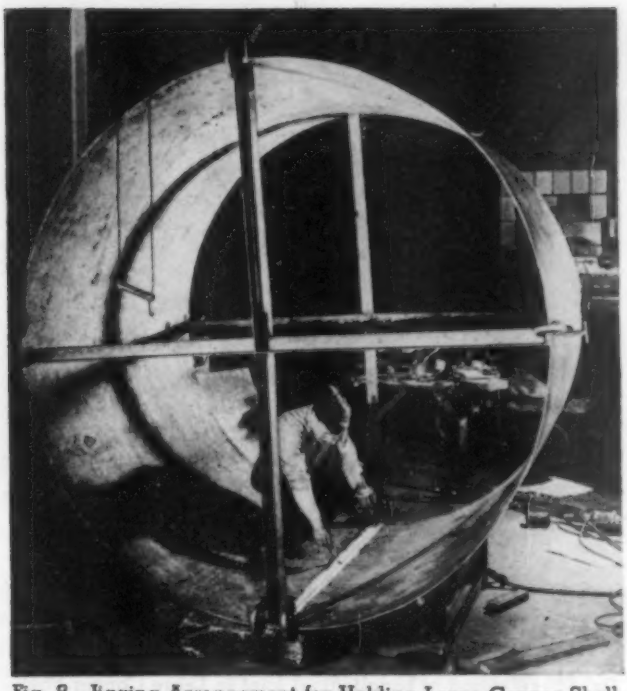


Fig. 8—Jigging Arrangement for Holding Large Copper Shell for Longitudinal Seam. Fluxing Joint Prior to Preheating and Welding

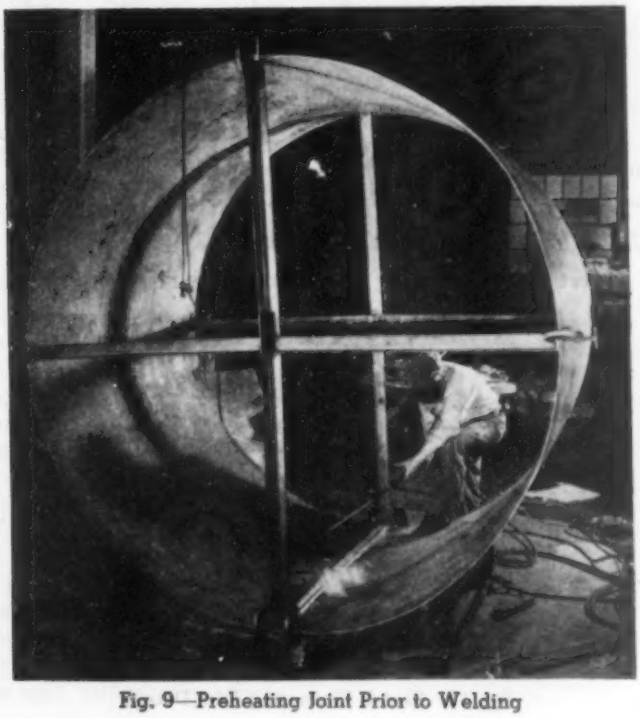


Fig. 9—Preheating Joint Prior to Welding

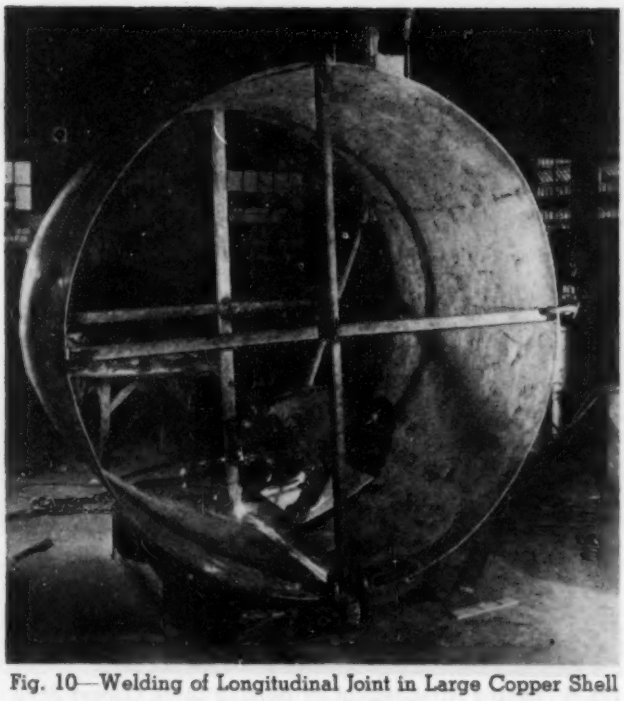


Fig. 10—Welding of Longitudinal Joint in Large Copper Shell

ures 2 and 3 show the weld in deoxidized copper using copper silicon alloy welding rod.

Table 1—Carbon Arc Welding Deoxidized Copper

Thickness Base Metal, In.	Miter	Root Aperture, In.	Filler Rod Size, In.	Carbon Diameter, In.	Closed Circuit Amperes	Closed Circuit Volts
1/16	None	3/32	1/8	1/4	120–140	20
1/8	None	3/32	3/16	5/16	200–220	35
3/16	45°	1/16	5/16	1/2	280–320	40
1/4*	45°	3/32	3/16	3/8	280–320	40
...	...	...	1/4	1/2	360–400	40
3/8	45°	3/32	1/4	3/8	330–370	35–40
..	...	...	1/4	1/2	380–420	35–40
..	...	...	5/16	1/2	400–440	35–40
1/2	45°	3/32	1/4	3/8	330–370	35–40
..	...	...	5/16	1/2	500–540	35–40
..	...	...	3/8	1/2	500–540	35–40
3/4	37 1/2°	3/32	5/32	3/8	340–380	35–40
..	...	...	1/4	1/2	400–440	35–40
..	...	..	5/16	1/2	440–480	35–40
..	...	...	3/8†	1/2	460–500	35–40
..	...	...	5/16†	1/2	460–500	35–40

* Multiple bead welding.

† Parallel beads to minimize heat effect on base metal. Preheat to 400° F., 3/16 in. thick and heavier.

Inert Gas Arc Welding

Inert gas arc welding is also being used successfully for

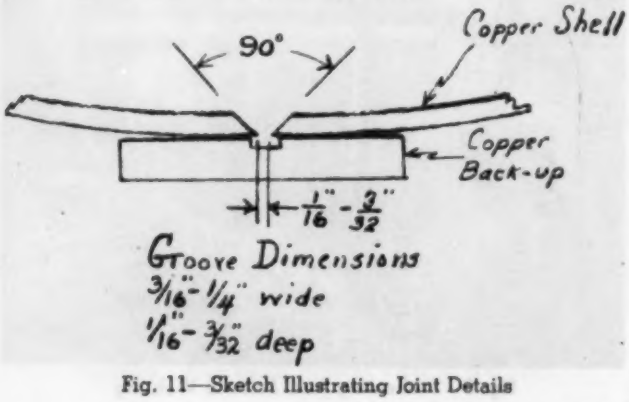


Fig. 11—Sketch Illustrating Joint Details

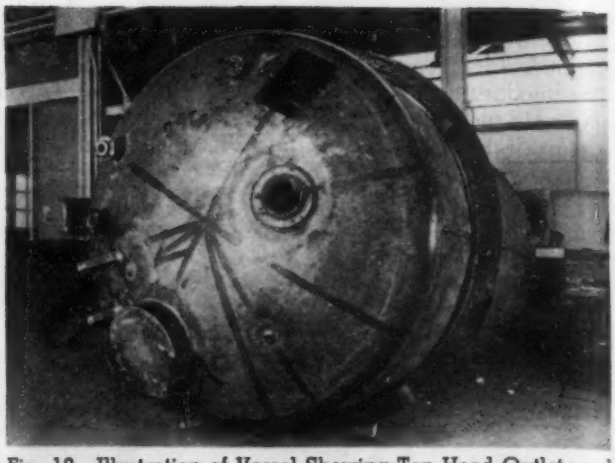


Fig. 12—Illustration of Vessel Showing Top Head Outlets and Connections. Head Butt Welded to Shell. All Connections and Manhole Carbon Arc Welded to Copper Head

the welding of deoxidized copper. For thicknesses 1/8 in. and heavier, it is recommended that a filler rod be used. Phosphor bronze, Grade C or D and copper silicon alloy have proved satisfactory for this method. Excellent density of deposited weld metal free from porosity and slag pockets is obtained because of the shielding blanket of inert gas which eliminates the necessity of using flux.

Vessel Fabrication Using Carbon Arc Method

After the vessel has been properly designed, it is suggested that the welding procedure be qualified along with a welder qualification. These qualification tests should be made to meet the following minimum properties in the weld: Tensile strength (nonreinforced), not less than 90° of the minimum tensile of the base metal, 27,000 psi.; free bend (root and face), 25% in 2 in. minimum.

Figures 4, 5, 6 and 7 show the recommended setup for procedure and welder qualification tests. A grooved copper back-up is used to obtain reinforcement on the underside which then makes the joint equivalent to a double-welded butt joint. Hold-down bars are necessary to use with flat plate samples to minimize the lift-up of the copper during welding. Flux (silicon bronze) is applied to the edges and areas adjacent to the weld in a thin alcohol paste form. The thickness of the copper shown is 3/16 in., beveled to form a 90° groove angle, root opening 1/16 in. Preheating to approximately 400° F. is recommended to insure maximum density of weld metal over the entire length of the weld. Two-bead

Fig. 13—Another View of Top Head Showing Steel Angle Bar Welded to Copper Head

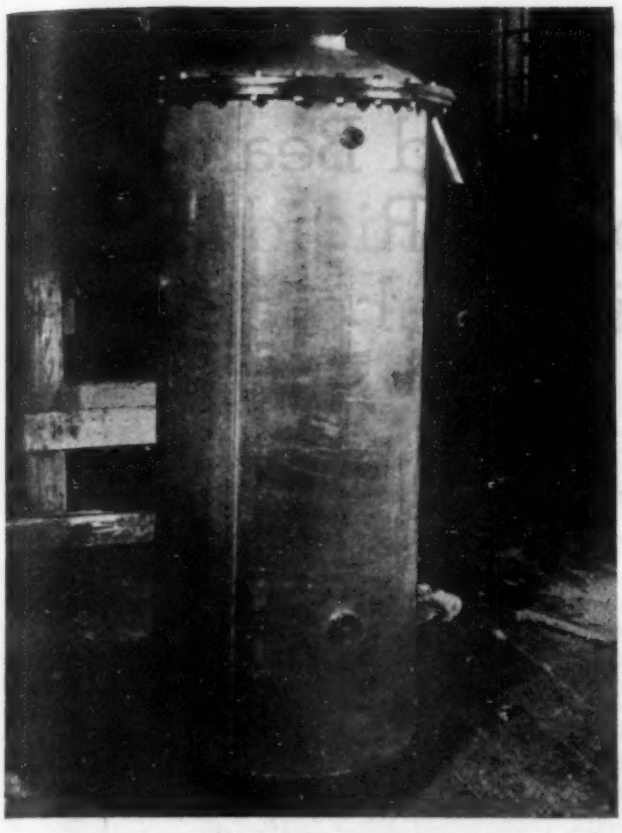


Fig. 14—Small Diameter Copper Pressure Vessel (50 Lb. WP) Welded by the Carbon Arc Method Using Copper Silicon Alloy Welding Rod

welding is used since the vessel fabrication would require two beads because of the welding setup (Fig. 8).

Figures 8, 9 and 10 illustrate the setup used for welding the longitudinal seam in the shell. Figure 11 is a cross-section sketch showing the joint setup details. Tack welding every 12–14 in. should be done to maintain edge alignment along the joint during welding. Because of the high heats involved, lifting of the copper off the back-up will occur during welding. This is minimized by proper hold-down bars, held down along the edges of the joint. If this is not done, it is necessary to stop welding when lifting occurs and hammer both edges back down on the back-up bar. To further minimize lifting of the copper, two beads of weld metal should be deposited from one side. The first bead is deposited using a $^{5}/_{32}$ or $^{3}/_{16}$ in. welding rod with lower heats (300 amp.) and faster lineal welding speed than if only one bead were deposited using $^{3}/_{8}$ in. welding rod with high heats (550 amp.). Using the multiple bead procedure, less heat build up is obtained in the copper which lessens the tendency of lift up from the back-up bar. This will also eliminate the tendency for a step effect at the weld due to one edge of the copper lifting more than the other. The second bead is deposited using a $^{3}/_{16}$ or $^{1}/_{4}$-in. welding rod with higher heat (400 amp.). Less trouble will be experienced with this bead, providing the first bead was deposited carefully and the above precautions followed. Attempting to fill in the joint groove in one pass, there is a tendency to disturb too much of the copper base metal which causes pin hole porosity, particularly on the surface of the deposited weld metal. Using the large diameter filler rod ($^{3}/_{8}$ in.) for this operation quite often does not permit complete penetration of the weld metal which again causes porosity in the root of the weld.

The underface of the weld which is on the outside of the shell is chipped out to remove excess weld metal and to insure complete penetration and solid weld metal. A

Fig. 15—Another View of Copper Vessel in Fig. 14 Showing Bottom Head Welded After Inserting in Shell

sealer bead is deposited using a $^{3}/_{16}$ in. diameter welding rod which gives a satisfactory appearing surface on the outside of the shell. If satisfactory penetration is obtained with the first bead deposited on the other side resulting in a minimum of porosity in the root, the sealer bead will be sound and deposited with no trouble.

Figure 12 illustrates the top head of the vessel. Both heads are butt welded to the shell after two shells, as shown in Fig. 8, were butt welded to form a girth seam. The cylindrical seams are welded from the outside surface of the vessel using a ring back-up without a groove. The edges are prepared by beveling to form a 90° groove angle and the head skirts are machined so that the thickness is equal to that of the shell at the joint. Again multiple bead welding is recommended to minimize waves in the copper adjacent to the weld and to insure proper penetration of weld metal to avoid porosity at the root of the weld. Any lifting or movement of the copper during welding must be immediately corrected by stopping and hammering the copper back in alignment. If this is properly done, an even, uniform contour of the vessel is maintained.

Steel supporting members or brackets are welded to the copper vessel by either the carbon or the inert gas arc-welding method. Figure 13 illustrates two steel right angle brackets fillet welded to the copper vessel. It is imperative that no fusion of the steel occurs to insure maximum density and maximum ductility of the weld metal. To minimize the melting of steel, an oversize bronze welding rod should be used with the arc at all times being maintained on the bronze filler metal and copper base metal.

Figures 14 and 15 illustrate a copper pressure vessel completely fabricated by the carbon arc method. The vessel was designed for 50 lb. working pressure, using 0.064-in. thick shell (cold rolled) and $^{1}/_{8}$ in. thick heads. To insure alignment of the copper edges and to prevent lifting of the copper during welding, welding of the longitudinal seam was done on a hold-down, back-up jig as shown in Fig. 1. The bottom head was inserted in the shell and fillet welded.

Conclusion

The foregoing remarks and illustrations clearly indicate that deoxidized copper can be satisfactorily arc welded. The precautions and conditions mentioned are of prime importance and the recognition of them will result in a low cost, superior product.

Standardized Welded Beam Connections and Special Rigid Frame Details of New Airco Laboratory*

By LaMotte Grover†

THE use of many standardized welded beam-end connections, and some unusual special welded details for rigid frame bents spanning shop areas, are features of special interest in the 580-ton structural steel frame of Air Reduction's new Apparatus Research Laboratory at Murray Hill, N. J., near Summit. The main building is a welded steel frame structure throughout, of modern functional design, with reinforced concrete floors and brick exterior walls with continuous steel-sash windows. It contains a total of 107,700 sq. ft. of floor space, with 53,500 sq. ft. on the ground floor. It is of two-story height in general, with a modern cafeteria and sun deck on a third floor over the center portion of the building.

The work done in this laboratory pertains mostly to the development and engineering studies of processes, apparatus and equipment for the industrial uses of gases such as oxygen, acetylene, nitrogen, hydrogen and some of the rarer atmospheric gases including argon and helium. These activities are devoted primarily to processes for joining and severing metals, although some of the work will be related to the use of gases in the refining of molten metals.

Also, research and development for arc welding machines and equipment will be carried out in this laboratory. However, most of the arc welding electrode research and development, and a great deal of research pertaining to processes for the production and purification of industrial gases, are carried out in laboratories at other locations.

The main or east wing of the building is 306 by 141 ft. with a 60-ft. rigid-frame shop bay running the full length but divided into a large main laboratory shop of 177-ft. length at the east end, served by a 10-ton welded bridge crane, and a large hot work laboratory with furnaces, at the west end, provided with special ceiling fans and vents of 100,000 cfm. capacity, which will change the air of the hot work laboratory completely within 3 min.

The main laboratory shop is flanked on the south by a well-equipped machine shop. The hot work laboratory is flanked on the south by several special-development laboratory and testing rooms.

The wide, unobstructed main laboratory shop areas with ample overhead clearances, provided by the rigid frame construction, will permit the research and development of large equipment, as well as apparatus, to be carried through entirely in this building, to the completion of prototypes ready to be placed in production.

Along the north side of this main wing, on the ground level, are the main electrical, metallurgical, mechanical testing, chemical and welding and cutting laboratories. On the floor above these are a library and several special laboratory rooms that can be supplied with oxygen, acetylene and any other gases needed, through an elaborate and extensive system of welded piping which serves this entire main wing (Fig. 5).

In the roomy main entrance lobby of ultra-modernistic design with large clear glass front, at the center of the building, there will be displays and exhibits of apparatus and equipment.

The main floor of the 106- by 48-ft. north wing is occupied by a large drafting room, blueprint room and vault. Above them are the administration offices and the accounting and purchasing departments.

Both floors of the 133- by 36-ft. west wing are occupied by offices, conference rooms and private or semiprivate research study rooms with steel partitions that can be moved easily to vary the sizes of these rooms to meet future needs.

Three basic types of lighting are utilized to meet the various requirements: fluorescent, incandescent and mercury vapor. A paging system with soft-toned reproducers in the individual offices is arranged with four separate channels, to permit paging in only one area when desired.

There is a central steam heating plant in an auxiliary building which also houses a service garage and a utility room. Another outbuilding houses a battery of acetylene generators and carbide storage room.

Structural Steel Details

Standardized beam-connection details were used wherever possible. These welded details are taken from the "Manual of Design for Arc-Welded Steel Structures," compiled by the writer and published in 1946 by Air Reduction, to provide structural engineers and steel detailers with technical data and instructions for the economical and technically suitable design of welded structures. This manual contains a complete set of beam-safe-load tables, expanded to include identifying piece-marks for the standardized welded connections to be used, for each size of beam and span length covered by the conventional beam-safe-load tables. This standardization not only saves much time in design, but because of the duplication involved it facilitates fabrication as well as shop and field inspection.

The welded details, in general, for the rigid frame bents, Fig. 2, and for column bases and other ordinary details, conform to sketches taken from a set of plate drawings which have been included in the above-mentioned manual, to represent what seems to have become

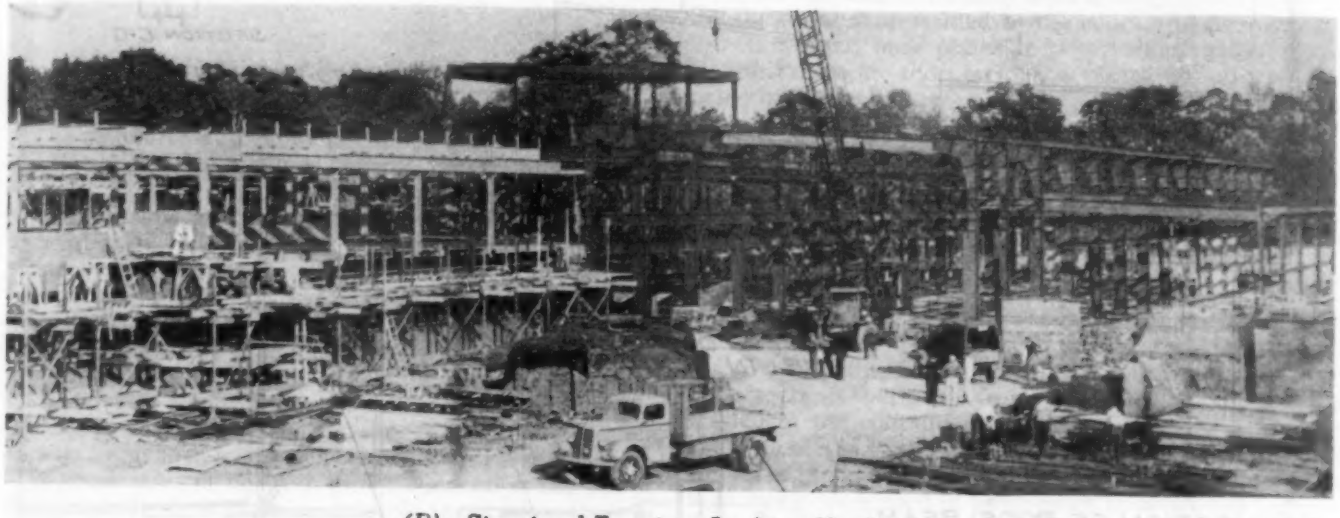
* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† Welding Engineer, Air Reduction Sales Co., New York, N. Y.

the best-accepted practice for welded buildings, based upon experience on the part of leading fabricators of welded structures. The behavior of the standardized types of welded beam-end connections has been investigated very extensively at Lehigh University in projects of the Welding Research Council of the Engineering Foundation.

Many of the special structural connections were de-

(A)—Exterior View of Laboratory, Looking Southeast at Main Entrance



(B)—Structural Framing, Looking Northeast

(C)—Erection of Rigid Frames, Looking Toward End of East Wing

Fig. 1

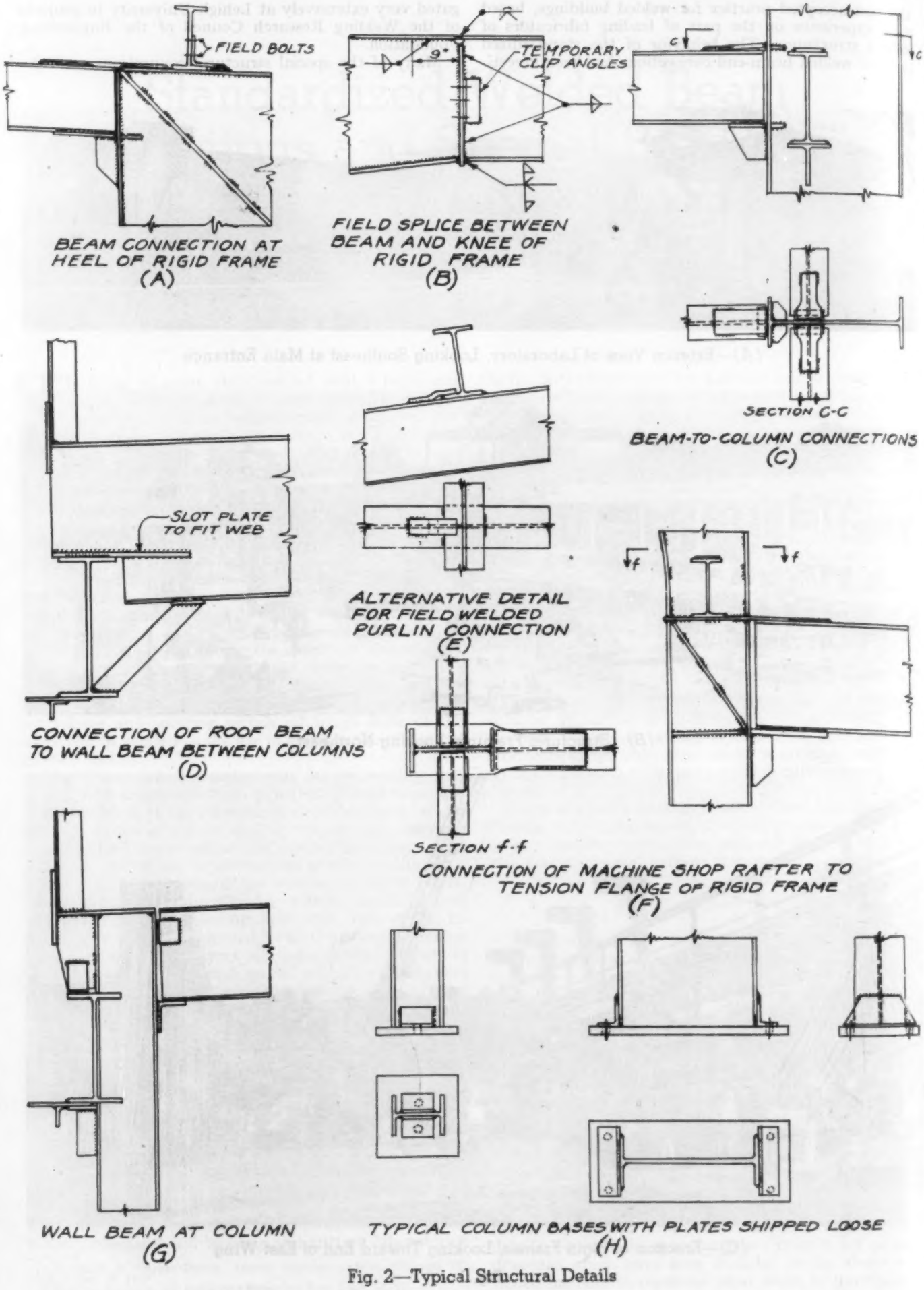


Fig. 2—Typical Structural Details

signed with the aid of a comprehensive set of diagrams provided in the Manual for the rapid graphic solution and proportioning of welded connections subjected to eccentric forces. These diagrams are based upon formulas developed by calculations similar to those used in the conventional methods of computing the stresses in a group of rivets subjected to an eccentric load, except that in some cases, such as that of a beam seat or a pair of framing angles, full account is taken of some eccentricities that are customarily neglected in riveted design. By use of the diagrams, this further refinement is accomplished with no additional work on the part of the designer.

The dominant thought governing the detailing of the structural steel was to realize the fullest economic advantages of welding, by including a saving in shop fabrication costs as well as the usual saving in weight and cost of steel material. To this end, the connections were detailed so as to require a minimum number of holes for erection bolts, and in such a way as to eliminate or minimize the shop handling of comparatively heavy material to punches or drills.

Choice of Details for Beam-End Connections

The standardized beam-end connections offer for most cases a choice from three general types: angle-seats, stiffened T-seats and framing angles, general preference from the viewpoint of economy being accorded in the order as mentioned, especially in the case of beam- to-column connections when the use of framing angles would require extra handling and punching of heavy columns for erection bolt holes.

For this building it was possible to use seat-type supports for most of the beam-to-column connections, Fig. 5. However, where beams framed into other beams or girders, it was sometimes necessary to use a framed connection because of insufficient clearance for a seat.

In some cases of beam-to-girder connection the use of such framed connections is advisable (even when there is clearance for a seat) in order to throw all of the punched holes for erection bolts into one class of members. For example, the details might be arranged so that all the work on columns and secondary beams would be done on the welding floor or skids, with no holes provided in these members that would necessitate their being handled through punches or drills. Only the girders framing into the columns, with punched holes in their webs for erection bolts of the secondary beams, would have to be sent to the punches.

Sometimes, when a member must be provided with holes in the web, perhaps for tie rods or for erection bolts, one can still help matters by avoiding holes in the flanges, which would throw the member into a more expensive classification of fabrication.

When a seat is used to carry the reaction of a beam, it is not necessary and is usually undesirable to connect the web of the beam to the support, unless the arrangement is such that a suitable and practical type of top flange connection cannot be used, in which case flexible side clip angles are sometimes used. Tests have indicated somewhat better technical performance for a flexible top angle, welded only along its toes than for side angles. Also, they have shown remarkably good performance for the top-flange connection plate, which is provided with a relatively small cross-sectional area when the connected beam is designed as simply supported.

There are very few if any cases of beam-to-column connections in which the small amount of restraint introduced by a comparatively light top plate could be detrimental, and in most cases such restraint increases the load capacity of a frame, even though it has been designed as having hinged beam connections.

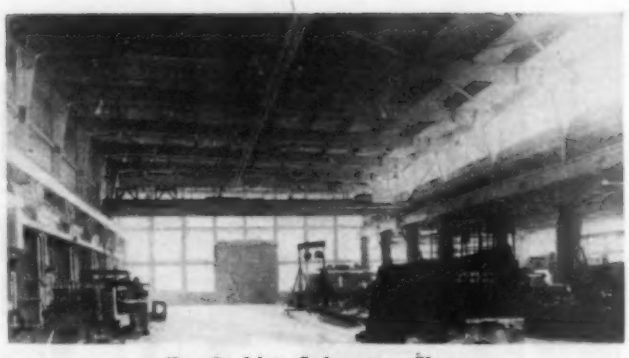


Fig. 3—Main Laboratory Shop

Since the beams seats for this project were shop welded to the columns, the column base details (taken likewise from the Manual of Design) were arranged with connection material shop welded to the column members (Fig. 2). For small base plates it is expedient under usual circumstances to shop weld the plates directly to the bases of the columns.

As usual for a building of this type, quite a number of circumstances were encountered which required specially designed details. Some of these are shown in Fig. 2.

Rigid Frames and Restrained Beam Connections

The rigid-frame bents spanning the main laboratory shop bay (Fig. 3) are composed of rolled steel-beam crane-runway columns, rolled steel-beam rafters and welded knee sections built up from plates. The knees were welded to the columns in the shop. For the field connections of the knees to the rafters, as well as the shop splices in the knee-and-column members, full penetration butt welds were used in most cases to splice the tension flanges, and fillet welded "butt-plate" splices were used for the webs, and in some cases for the compression flanges, also. (Fig. 2 B & F.)

A butt-plate web splice is one that is made by providing an interposed transverse stiffener plate of about the same width as the flange plates, at the location of the splice. The webs of the spliced sections are butted against this transverse butt plate on either side and connected to it by means of fillet-welded T-joints. If the flanges are likewise butted against this butt plate, these flange plates are bevelled to provide groove welds.

The butt-plate stiffener, in the present instance, was welded to the end of the rigid frame knee section in the shop. A pair of erection clip angles (Fig. 2B), arranged like framing angles, were tack welded to each end of the rafter beam. Erection bolt holes were punched in the outstanding legs of these angles, to match holes in the butt-plate stiffener. These erection clips proved to be adequate for holding the parts in position until the flange butt joints were tack welded. With this arrangement, all the erection bolt holes could be punched in small parts that were easily carried to the punches, and no holes were punched in the column or rafter sections. After the rafter-to-knee splice welds had been virtually completed, the temporary erection clips were removed to permit the web-splice fillet welds to be completed over the portion of the joint that had been covered by these angles.

Since this project was designed before the 1946 Edition of the Specification of American Institute of Steel Construction was issued, no advantage could be taken of the 20% increase in the allowable bending stress for negative

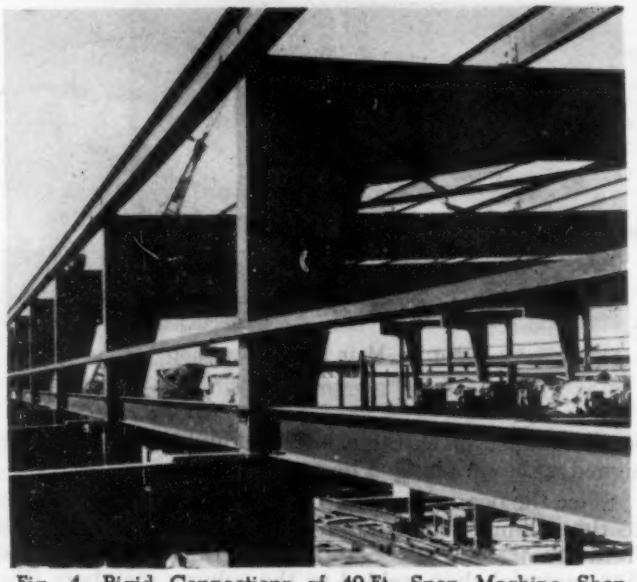


Fig. 4—Rigid Connections of 40-Ft. Span Machine Shop Rafters. See Also Fig. 2 (*F*)

moments in the beams at their restrained ends; nor could the maximum unit bending stress (F_b in the A.S.I.C Specification) in the columns be increased to 24,000 psi., as now provided when the bending stress is induced by gravity loading of such restrained beams.

These provisions for increased allowable unit stresses (which, in effect, constitute a conservative start in the application of the plastic theory of design) could have been applied to some of the beams and columns in other parts of the building with restrained connections. Alternately, they could be designed, under the present specifications, to conform to the "semi-rigid" type of construction, with partially restrained connections designed upon the basis of available research information, to possess a dependable and known moment capacity. This method of design is described and discussed in the "Manual of Design for Arc-Welded Steel Structures" which has been mentioned.

A research project of the Welding Research Council has been started at Lehigh University, which is intended to lead to the development of a practical and more rational method of analyzing frames with restrained connections, involving the plastic theory. The use of such a method should make possible a considerable further saving in weight of steel in the main members of many frames, together with a more balanced design than one resulting from the conservative but arbitrary increase in working stresses by a fixed amount such as 20%.

Of particular interest, the connections of the inner ends of the 40-ft. beams spanning the machine shop are designed to develop virtually full restraint, where they join the tension flanges of the rigid frames spanning the large main laboratory shop. Because of the biaxial tension at the top flange connection (Figs. 2 and 4), some special consideration was deemed advisable for the details at this point. Conditions were somewhat more complicated because the steel beam section that was adequate, in general, for the 40-ft. span had to be reinforced by coverplates for negative moment, immediately adjacent to the knee of the rigid frame, under the specifications prevailing at that time which did not permit the increased allowable bending stresses which have been mentioned.

With welded construction the top connection plate could be extended easily to serve also as a reinforcing coverplate. Since the shop-welded joint between the rolled column section and the bottom of the fabricated rigid-frame knee could be located conveniently at the same elevation as the top flange connection of the 40-ft. beam, it was decided to extend the top connection plate across the column and let it serve also a third purpose, as an interposed butt plate, welded to the column below and the knee above. A stiffener would have been required in any event to back up a large top connection plate of this kind, even if it had been butt welded against the face of the column at a different location.

The beam-seat for this connection was made similar to the standardized T-seat for the reaction to be carried except that the horizontal element was extended to serve also as a bottom coverplate for the beam in the region of high negative bending moment.

For restrained connections it is sometimes necessary to extend the horizontal element of a seat somewhat, to accommodate the length of longitudinal fillet welds required for transferring the thrust of the bottom flange to the beam seat. In all such cases the T-seat is fabricated from plate material by welding, instead of being cut from a wide flange beam.

In the special connections for these 40-ft. beams, $^1/_8$ in. extra depth was allowed between the top and bottom connection plates, for clearance to facilitate entering the end of the beam during erection. This clearance proved to be sufficient, but an additional allowance must be made in a case of this kind, for any shrinkage due to welding in the vicinity, which would tend to reduce the clearance.

Because of the biaxial stress at this special connection, the use of a reduced section top connection plate (Fig. 2 (*F*)) was deemed especially advisable, to encourage any plastic deformation to take place in the free part of the reduced section, between the face of the rigid frame knee and the fillet welds at the end of the connection plate, which attach it to the top flange of the 40-ft. beam.

The transverse fillet weld across the end of such a top plate, used in conjunction with the side fillet welds, not only reduces the required length for making this fillet-welded connection, but provides a better distribution of stress than longitudinal fillet welds alone.

For all the other restrained beam-end connections of this project, the top flange connection plates were shipped loose and were butt welded to the face of the column, the groove formed by the beveled end of the plate being backed up with a small bar (Fig. 2 (*C*)). This detail facilitated the depositing of a thoroughly sound weld in the groove.

Special Details

A type of purlin connection (Fig. 2 (*A*)) that had been

Fig. 5—Typical T-Seat Beam-to-Column Connections. Note System of Welded Piping for Industrial Gases

used previously, in riveted construction, by the engineering and contracting firm for this project, proved to be suitable for this job, even though the copying of riveted details for welded construction is not usually conducive to the best economy. The use of this detail did not require the rafters to be punched for erection or field bolts. The lighter weight purlins, 12 in. at 16.5 lb., were permanently field bolted to the clip angles. The heavier ones, 12 in. WF at 25 lb., which serve also as struts of the lateral bracing system, were bolted for erection and subsequently field welded.

In Fig. 2 (*E*) is also illustrated a type of lug or clip which can be welded to a rafter to facilitate the location during erection of a purlin that is to be field welded. This detail eliminates the punching of the purlins as well as that of the rafters.

The spandrel beams and outside wall beams (Fig. 2 (*G*)) of this structure, as well as some of the interior beams spanning between columns, were provided with so-called "flexible" end connections, to conform to common practice in the United States. A large part of the structural welding research in this country has been directed toward the determining of the behavior of the flexible types of beam-end connections.

Structural engineers visiting this country from Europe have been greatly surprised at the use made here of welded flexible connections. For the most part, especially on the Continent, engineers have considered it axiomatic that the fullest exploitation of the advantages of welding should be realized by employing rigid frame or continuous types of construction.

In parts of the United States which are subject to damage from earthquakes or hurricanes, a very pronounced appreciation has been developed for benefits of continuity and the fact that it can be provided more effectively and at less cost by welding than by any other method.

Perhaps an undue amount of emphasis has been placed in this Country upon the convenience in fabrication and erection of using flexible types of connections for multi-story tier buildings. This preference may have been based too much upon practices developed in riveted and bolted construction. In at least one case that has come to the attention of the writer, a continuous welded building has been detailed so that it was erected as easily as a simple structure would have been.

Of course, the direct welding of connections eliminates the cost of fabricated connection material. In directly welded connections it is usually more important than in the case of directly riveted connections, to analyze frames rationally and make sure that a sufficient amount of properly located welds are used, to insure that the inevitable small amount of plastic deformation will occur in the base metal without failure of the welds; for example, in the case of spandrel beams connected directly to columns.

It seems quite likely that the results of current programs of structural welding research in this country, if carried far enough, will lead to a large increase in the use of rigid welded connections with an accompanying increase in the over-all cost savings afforded by the use of welding.

Wigton-Abbott Corp. of Plainfield, N. J., were the architects, engineers and general contractors for this new Airco laboratory which was designed and constructed under the direction of the Engineering Division of Air Reduction. The Ingalls Iron Works Co., subcontractors for the structural steel, did the fabrication at their Verona, Pa., plant. The steel was erected by A. J. McNulty & Co. of New York City.

Rigid Structures

By Martin P. Korn*

THE phrase "all-welded rigid design" is sometimes used incorrectly with reference to structures. It has appeared in articles on rigid frames. It has been used also in THE WELDING JOURNAL for buildings of simple design. Plainly that phrase cannot fit both types of design—one with fully restrained end connections, the other with unrestrained end connections. Such misuse cannot but reflect adversely on the good purpose of any article.

Any type of steel building frame falls under one of three basic types of design whether it be welded or riveted. The A.W.S. Building Code and the A.I.S.C. Code classify them as follows:

Type 1. Rigid frame
Type 2. Simple framing
Type 3. Semi-rigid framing (partially restrained)

No descriptions can more briefly and more accurately describe a type of building design. "All-welded rigid design" implies a rigid frame and is merely a contraction of the phrase "all-welded rigid frame design." If one prefers this longer description to the above simpler ones, it cannot be used indiscriminately for any type of welded building.

Apparently there is confusion on this point among some welding authorities who are not familiar with structural design. One example is a statement claiming that only those who have and know the A.W.S. Building Code classifications could properly classify the design of a welded building. That leaves others with no recourse but to concoct their own. Thus came the fluorescent phrase "all-welded rigid design" for welded buildings with free-end connections, a false classification despite its powerful ring. Plainly the premise for this statement is not correct.

Here are the facts briefly: The above classifications in the A.W.S. Code fit into every language universally with the same meaning except for the type numbers which are inconsequential and American by choice. For a period of years before the A.W.S. Code added those classifications, welded structures designed built here and abroad that were classified as rigid frames, simple framing or partially rigid framing. It was a fact known to many structural engineers of wide experience. I knew it from my own experience and research. It was this fact that I submitted as a member of the Building Code Committee, A.W.S., when I proposed that we include welded rigid frames in our code. Such action was approved and became part of the Tentative Code, Edition of 1941.

It is hoped that these remarks will serve a constructive purpose toward factual presentation of welded structures. The field of structural welding is wide open. It offers possibilities in modern creative design greater than any others that I have observed in 40 years experience with structures. All eyes are upon us and many are critical. The living structure can more truly attest the accomplishments of welding than any fire from words. It behooves us to guard those accomplishments against misfire.

* Consulting Engineer, Dearborn, Mich.

Production Methods of Low-Temperature Silver Alloy Brazing*

By A. M. Setapen†

THE use of low-temperature silver brazing alloys has been increasing steadily and as they gain in popularity more applications develop wherein they become a definite part of high-speed automatic production methods. The use of brazing alloys containing silver dates back many, many years but only in the past five or six years has their use become widespread in what might be considered real high production. It is the purpose of this paper to describe how these alloys have been worked into high production methods and to give a detailed analysis of some of the more interesting applications.

The more popular low-temperature silver brazing alloys flow in the range of 1145 to 1600° F., the specific temperature depending upon the actual compositions. The other flow characteristics besides temperature of these different alloys vary considerably and it is generally true that the more free flowing alloys have been used to a greater extent on high-speed automatic production operations. There is one alloy[1] in particular which embraces many of the desirable properties of a production brazing material and it is this alloy that has been most widely accepted. Consequently, this paper will deal with applications where this composition has been used.

Heating Methods for Production Brazing

In any discussion on brazing, particularly production brazing, some consideration must be given to the different methods that are employed to heat the parts to brazing temperature. One of the most commonly used and most versatile methods of heating is the use of the oxyacetylene torch. It has been reported[2] that today over 63% of the manufacturers doing low temperature brazing employ the oxyacetylene torch for their heating.

The hand-operated torch is used in the early stages of the development of an application, on pilot runs or even on small scale production. It is always considered where the heat must be taken to the work, one of its chief assets. It is simple to handle and operate, convenient and very flexible. Another distinct advantage is the ability to heat work uniformly with it.

It is possible when using a torch to overcome the tendency, often experienced with other heating methods, of overheating one member of a joint in order to raise the temperature of the adjacent member sufficiently to cause good flow and wetting of the alloy. This faulty condition of unequal heating is more pronounced particularly with the high-speed methods of heating. In the operation of the torch, it is moved about, thus permitting uniform heating of the work. With other methods of heating, this, in most cases, is not practical.

Figure 1 illustrates an oil filter which was originally soft soldered, later welded, and now silver alloy brazed. The cleaned parts are assembled, fluxed and oxyacetylene torch brazed in three steps: (1) bronze bushing to steel head (2) head to steel shell and (3) steel ring to shell. Each operator averages 110 units in an 8-hr. day.

An intermediate process between that of hand torch brazing and fixed burner brazing (discussed later) is the use of a permanently fixed torch for production brazing.

Fig. 2—Semi-Automatic Brazing of Bosses to Steel Cover Plate Utilizing Fixed Oxyacetylene Torch

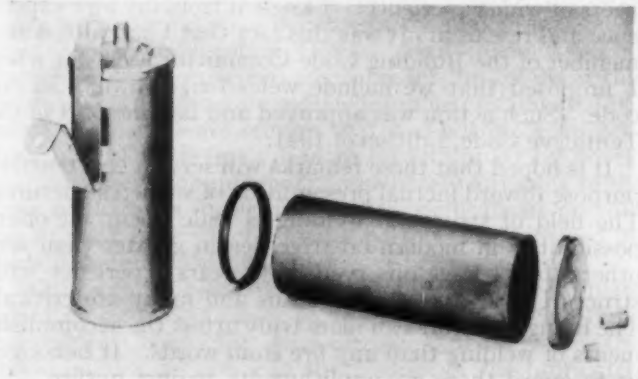


Fig. 1—Oil Filter. Left, As-Brazed; Right, Exploded View

* Paper presented before the 47th Annual Convention of the International Acetylene Assoc., Cincinnati, Ohio, May 20–21, 1947.

† Manager, Engineering Division, Handy and Harman, New York, N. Y.

[1] A proprietary alloy developed by Handy & Harman containing 50% silver called Easy-Flo. This alloy in many cases is being substituted presently by another proprietary alloy recently developed by Handy & Harman, having equally good properties but containing only 45% silver and is known as Easy-Flo 45.

[2] "A Special Study on Brazing" prepared in 1946 by *Steel* (Market Research Dept.)

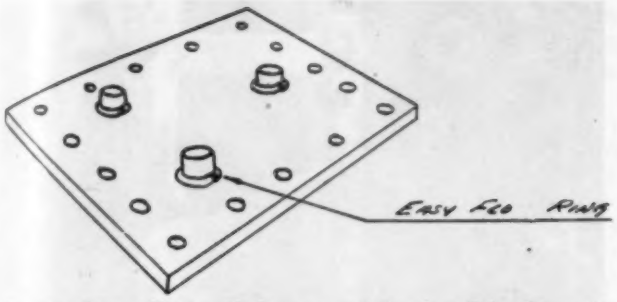


Fig. 3—Cover Plate with Bosses and Brazing Alloy Rings in Position

A semi-automatic control set-up for production brazing with preplaced alloy is illustrated in Fig. 2. A special three-tip assembly, utilizing oxygen and acetylene, is used for heating three bosses to be brazed to a steel cover for electrical connection boxes. With this three-tip assembly, it is possible to heat the three bosses simultaneously, the flames being applied from beneath the cover plate. The V-shaped piece of steel on top of the plate is used to hold the bosses in position.

Figure 3 shows the cover plate with the preplaced rings of low-temperature brazing alloy around the bosses. The rings are $1^1/_8$ in. I.D. made from $^1/_{32}$-in. diam. wire and two operators, one fluxing and assembling, the other doing the actual brazing, produce three covers per minute.

Fixed Burner Heating

The fixed burner method of heating, employing gas and oxygen or gas and air or oxyacetylene, is looked upon today with considerable favor because it is relatively inexpensive to install and flexible in its applications. A very interesting application of using fixed burners utilizing gas-air for high-speed production brazing is shown in Fig. 4. While this manufacturer happened to use gas and air, either propane or other suitable gas and oxygen could have been used equally well. Sixteen $^3/_8$-in. copper return bends or a total of 32 joints are brazed simultaneously in 45 sec. on a refrigeration coil. Rings prepared from $^3/_{64}$-in. diam. low-temperature silver alloy brazing wire are inserted into each end of the return bends after which they are assembled in place over the cleaned and fluxed tube ends. Two manifolds are used in parallel with 16 burners in each manifold staggered so that each joint is heated uniformly and for a predetermined length of time. The time is governed by a positive automatic reset timer and solenoid valve that shuts off the main gas supply leaving a pilot burning after the unit has been properly brazed. The brazed assembly is then moved out of the burners and another assembled unit is indexed in position for brazing.

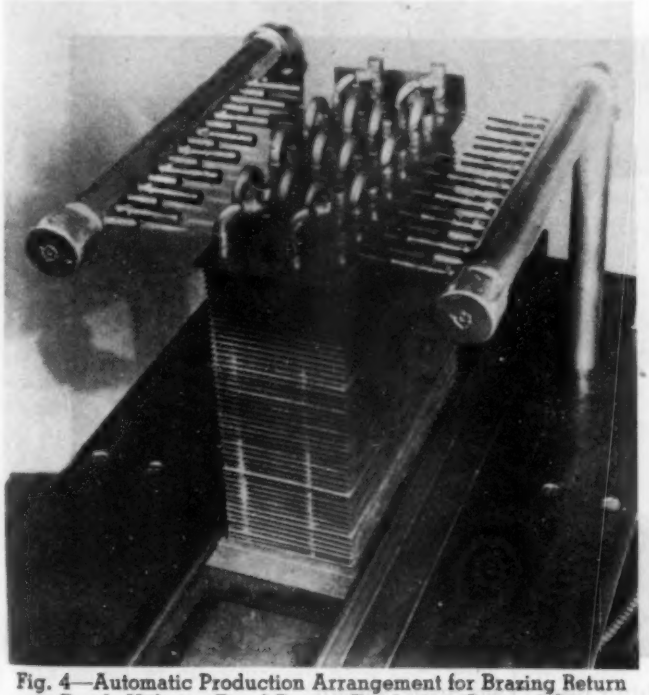


Fig. 4—Automatic Production Arrangement for Brazing Return Bends Utilizing Fixed Burner Employing Gas and Air

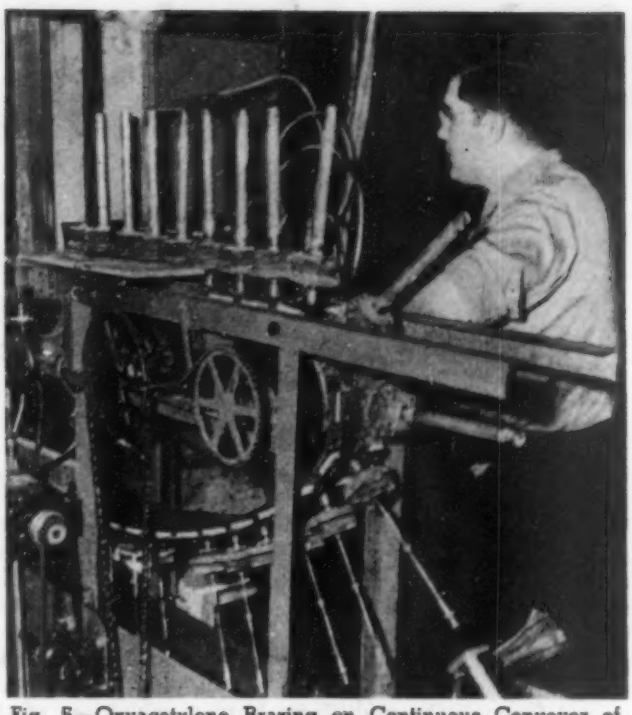


Fig. 5—Oxyacetylene Brazing on Continuous Conveyor of Thermal Coupler Parts

Another very interesting application of production brazing using fixed burners is in the manufacture of a thermal coupler unit as illustrated in Fig. 5. A brass flange and a copper plug are brazed to a $^3/_4$-in. diam., 10-in. long copper tube using rings of a low-temperature brazing alloy. Production is at the rate of 2000 units in an 8-hr. day with two operators, compared to 1000 units requiring eight operators by the former method of hand brazing. Rejects were reduced better than 50%.

This process, like all production brazing processes, is divided into five operations: (1) cleaning of parts, (2) assembling, (3) fluxing, (4) brazing and (5) final cleaning and inspection. As cleanliness is essential to good brazing, the parts are thoroughly degreased and all oxides and dirt removed. This is immediately followed

Fig. 6—Thermal Coupler. 1, Assembled; 2, Ready for Brazing After Fluxing; 3, After Brazing

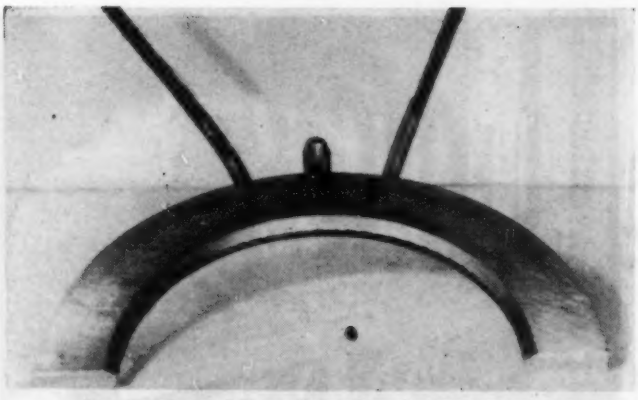


Fig. 7—Special Type Semi-Circular Ring Burner

by fluxing of the joint surfaces and then assembling.

Assembling consists of placing a ring of brazing alloy $^{3}/_{4}$-in. I.D. $^{3}/_{64}$-in. wire around the copper tube and inserting it into the machined brass flange with the ring resting on the flange. The copper plug is then placed into the upper end of the copper tube resting on a counterbore. A ring of brazing alloy $^{3}/_{4}$-in. O.D. $^{1}/_{32}$-in. wire is placed on the plug. Brazing occurs when the assemblies are placed on the supports of the moving belt and are passed through the multiflame burners which are of the ribbon type, utilizing oxygen and propane. The parts are rotated while they move along through the burners thus facilitating uniform heating. Gradually the temperature rises to approximately 1200° F. at which time the alloy flows by capillary attraction throughout the entire joint area. After passing out of the flame of the burners, the assemblies cool to about 800° F. (this is important in all production brazing) and drop into a tank containing hot water. After a few minutes' immersion, which dissolves the excess flux, the coupler units are removed from the tank and are then inspected for quality of braze, surface porosity, alignment and subsequently given a hydrostatic test to check for leakers.

Figure 6 shows the thermal coupler: (1) assembled, (2) ready for brazing after fluxing and (3) after brazing.

Figure 7 illustrates a special type of ring burner semicircular in shape for use with various types of gases and oxygen. Burners of this type can be made in various

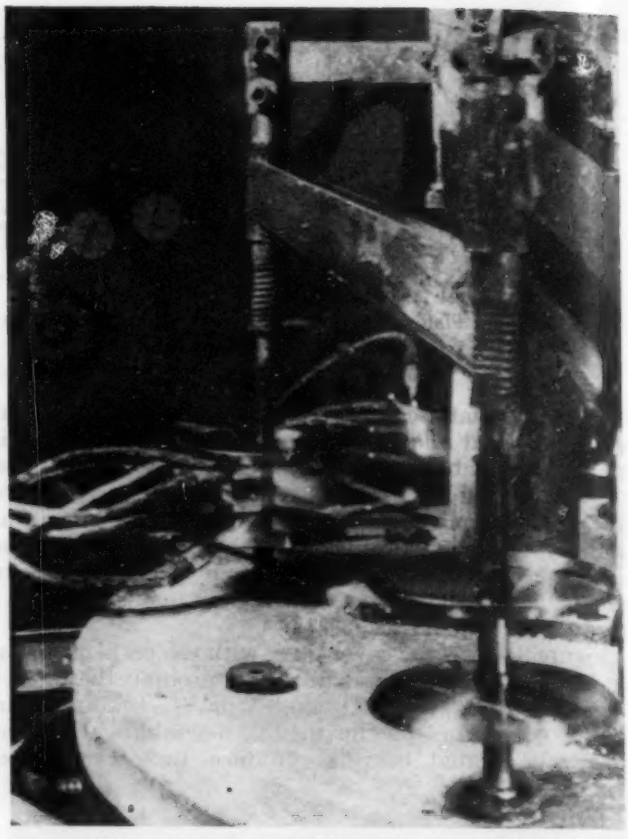


Fig. 8—Automatic Brazing of Fishing Reel Assemblies Utilizing Fixed Burners Employing Oxyacetylene

shapes and can be designed to use gas and air. In such cases, oxygen can be bled into the line for more accurate control of the brazing temperature. Articles similar to the four-wheel cycle shown in Fig. 12 can be brazed very suitably with this type of burner.

Methods of Handling Parts

The production brazing illustrated in Fig. 4 and 5 involve a straight-line conveyor for moving the parts in the

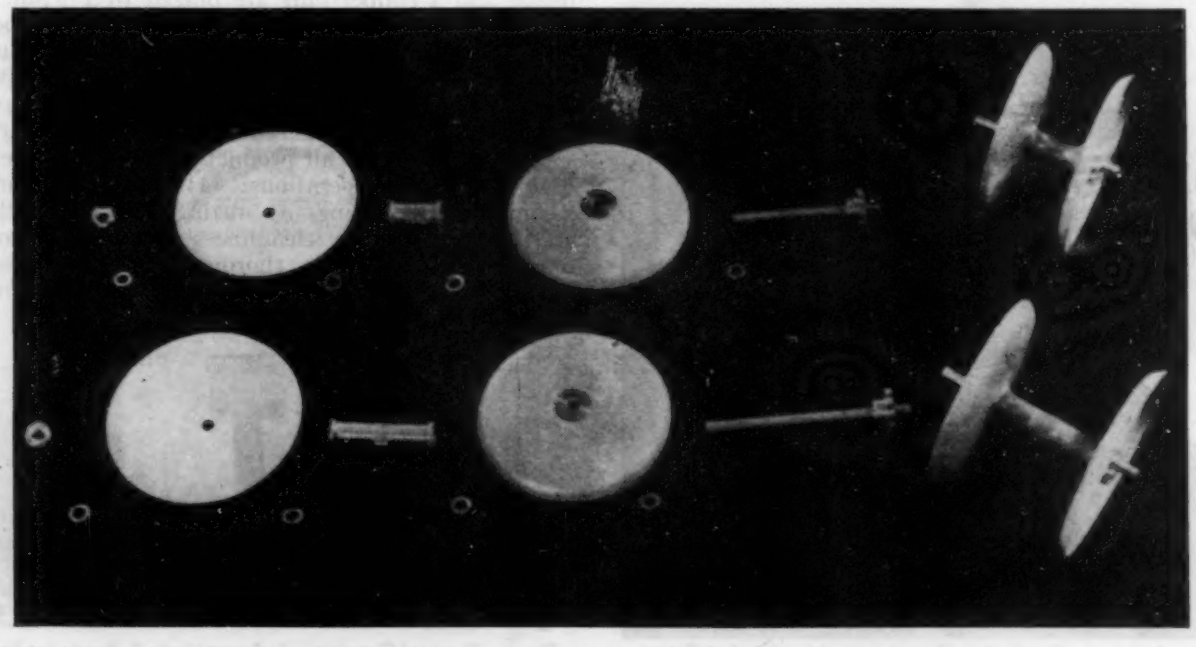


Fig. 9—Exploded View of Fishing Reel (Two Sizes Shown)

heating stations. In the case of thermal coupler, the conveyor moves continuously, while in the refrigeration condenser coil operation the conveyor is cycled intermittently.

A rotating table is very often used for conveying parts during the brazing operation. Figure 8 illustrates the brazing by oxyacetylene of a fishing reel assembly utilizing a rotating table for handling the parts. Figure 9 illustrates an exploded view of two different sizes of fishing reels. The assembly consists of stainless stampings and screw machine parts together with a brass spud gear. Low-temperature brazing alloy washers are used as shown. Washers generally are to be avoided if possible because more brazing alloy must be manufactured to obtain the required amount of material for brazing (a square piece with the outside corners and inner disk becomes scrap) than if round wire rings or coined rings are used.

Two sets of flames are employed for brazing, one set being used for preheating the parts. The flames are arranged to heat the assembly uniformly with careful attention given to avoid overheating the light stainless steel disks. A spring loaded fixture supports the parts during brazing. The table indexes automatically with a cam arrangement timed to give a high rate of production.

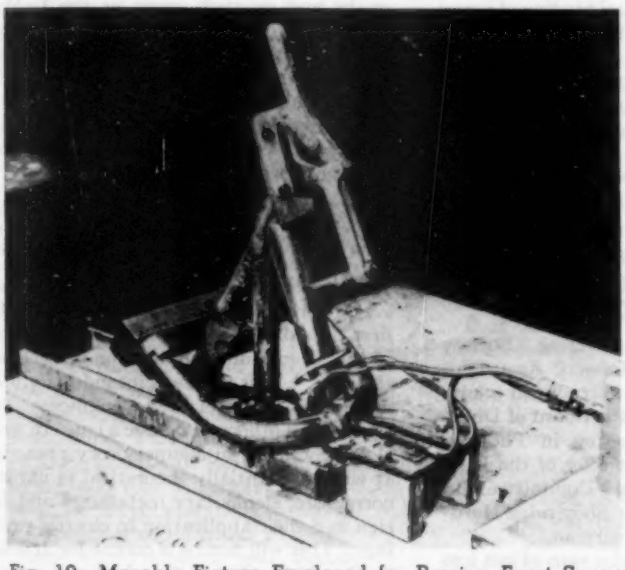


Fig. 10—Movable Fixture Employed for Brazing Front Support Member of Four-Wheel Cycle

Sometimes it is necessary to braze parts that are very irregular and do not conveniently lend themselves for handling on a conveyor belt or rotating table. In such instances, the parts are firmly jigged and the burners, supported in movable fixtures, are guided into position mechanically or manually to uniformly heat the parts to brazing temperature. There are applications also where the burners or means of heating are stationary and the parts, properly supported, are guided into position for brazing as illustrated in Fig. 10 which is a front support member of a four wheel cycle. A close-up of this same assembly sandblasted is shown in Fig. 11. Note the clean, neat joints that are obtained. There are no fillets or excess brazing alloy to remove, making it possible to produce these high strength joints at a very low cost. The completed cycle shown in Fig. 12 contains eleven joints all silver alloy brazed at a very high rate of production.

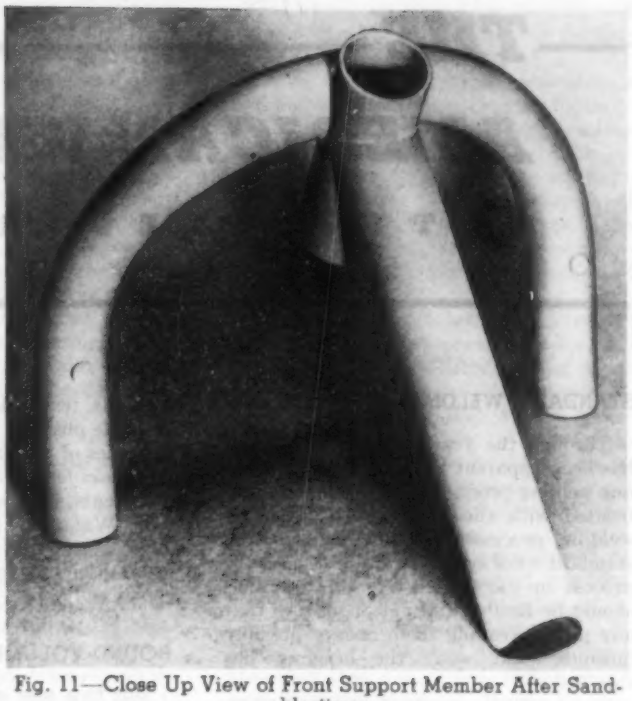


Fig. 11—Close Up View of Front Support Member After Sandblasting

Advantages Offered by Low-Temperature Production Brazing

It was stated earlier that the consumption of silver brazing alloys is increasing in those applications involving high production methods. There are many reasons why manufacturers are taking advantage of this method of joining. First, the free flowing, low-temperature alloys are ideally suited for continuous production. Second, by properly assembling and handling parts, it is possible to employ unskilled labor in the manufacture of items requiring skilled operators if produced by other methods. Third, accurate control of brazing alloy is possible because in most high-speed production applications the alloy is preplaced in some predetermined size and shape. Finally, by taking full advantage of all of the possibilities offered by low-temperature brazing, production can be accomplished at low cost. One manufacturer after another has learned that it is possible to join parts at a lower cost using the low temperature silver brazing process than by other methods of joining. In some cases, savings as high as 50% have been realized.

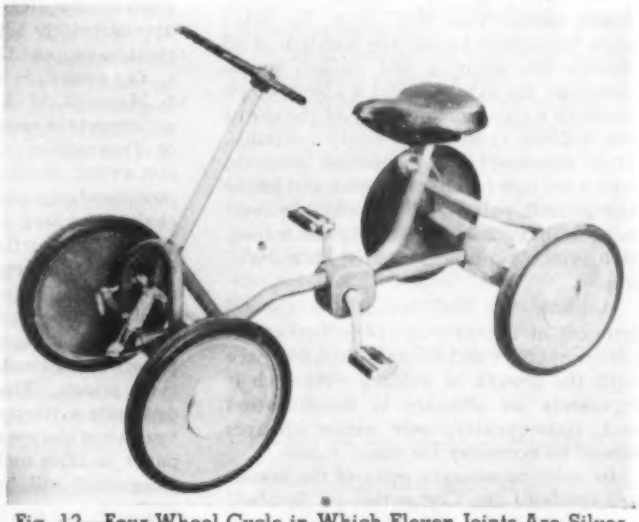


Fig. 12—Four-Wheel Cycle in Which Eleven Joints Are Silver Brazed

THE AMERICAN WELDING SOCIETY

ACTIVITIES—RELATED EVENTS

STANDARD WELDING SYMBOLS 1947

Through the years a definite situation has been apparent to the user of the various welding processes. He has been confronted with the problem of using new welding processes without access to a standard set of symbols adaptable to every process in use. Such a set of symbols should be flexible and yet precise, so that any person reading them cannot possibly misunderstand what the designer has specified.

In establishing the 1947 *Standard Welding Symbols*, the AMERICAN WELDING SOCIETY's Committee on Symbols has carefully considered the above problems, and rules have been adopted which adequately provide for all the needs of management, the designer and the shop man. It will be recalled that the 1942 Symbols and earlier publications, which date back as far as 1929, were concerned only with gas, arc and resistance welding. The revised edition of the symbols, however, covers 34 of the processes used in various industries throughout the country. This edition of the symbols should meet the needs of industry very satisfactorily, since the personnel on the committee represents every fabricating industry using welding as a production tool.

In the 1947 Standard the method of presentation has been revised from a form of rules, as presented in the 1942 standard, to a step-by-step presentation in lecture-type form. In addition to the improved method of presentation, the rules have been expanded to include a means of indicating welds having root penetration. Other features are the dropping of the confusing terms "near side" and "far side" from the nomenclature, the addition of 45 illustrations showing the various application of the symbols and a chart which provides a compact summary of the use of the welding symbols for ready reference. It is expected that inspection symbols, which are now being considered, will follow the general pattern of the welding symbols, so that combined welding and inspection symbols can be indicated on a drawing.

Actually this 1947 standard is the accrument of twenty years of industrial experience, effort and thought, keeping pace with the growth of welding. As such it represents an ultimate in simplification and, consequently, only minor changes should be necessary for many years.

In order to reassure users of the standard symbols, the Committee on Symbols has adopted a policy which will keep changes to a minimum, so that drawings, manuals, textbooks and standards will not be made obsolete by any ensuing changes.

Copies of the *Standard Welding Symbols and Rules for Their Use*, which is priced at fifty cents, can be obtained from AMERICAN WELDING SOCIETY Headquarters, 33 W. 39th St., New York 18, N. Y. The usual discounts to members on individual copies will apply.

BOUND VOLUMES WELDING JOURNAL

Due to a new arrangement, the Society will not be able, as in the past, to accept requests for the individual binding of issues of THE WELDING JOURNAL for the year 1947.

We will, however, furnish members, who want to have their Journals bound, with a 1947 bound volume cover at a cost of $1.00 plus postage.

The actual binding of the Journals will have to be completed locally.

LEON S. MOISSEIFF AWARD IN STRUCTURAL ANALYSIS FIELD IS AUTHORIZED*

A new Civil Engineering Society award—the Leon S. Moisseiff Award for excellence in the field of structural analysis—was authorized by the Board of Direction at its Spring Meeting in Phoenix. The Board accepted the offer of the Leon S. Moisseiff Memorial Committee, of which A.S.C.E. Director Shortridge Hardesty, New York, was chairman.

The committee offered a sum of not less than $4000, an estimated $1000 of which would be available to meet preliminary expenses for dies, engravings, etc., leaving approximately $3000 for a trust fund sufficient to support the award out of earnings.

The award, in memory of the late Leon S. Moisseiff, M. A.S.C.E. is to be made for an important paper in the current volume of *Transactions*, or any volume since the last award, dealing with the broad field of structural design—including applied mechanics, as well as the theoretical analysis—or constructive improvement of engineering structures, such as bridges and frames, of any structural material. Open to nonmembers as well as members of the Society, the award will not be given to papers recognized for award of other Society prizes. The Prize Committee may designate a "second order of merit" in any year when the excellence of more than one paper justifies such action, and a paper so recognized will be considered eligible to compete in the award for the next succeeding year.

Subject to ratification by the Board of Direction, the Executive Committee of the A.S.C.E.'s Structural Division will select the recipient of the Award, which will consist of a bronze medal and an appropriate certificate signed by the President and Executive Secretary of the Society.

Mr. Moisseiff died at his summer home at Belmar, N. J., on Sept. 3, 1943, at the age of 70. He had served as consulting engineer or designer on practically all the bridges connecting New York's five boroughs and on such spans as the Golden Gate Bridge at San Francisco, the Ambassador Bridge at Detroit, and the Delaware River Bridge at Philadelphia. He was the author of numerous volumes on bridge design and engineering, and the recipient of the Society's James Laurie Prize and the Norman Medal.

* Taken from June 1947, *Civil Engineering*, p. 60.

WELDING COURSE

The Division of General Education, New York University, will offer for the first time during the spring term, a course in the Theory and Application of Welding (VT-61). This course is intended for production heads, foremen, engineers, designers and others who have a concern with electric welding in a supervisory capacity. It will be essentially theoretical in nature, correlating elementary metallurgy and design and their application in electric welding. This will not be a course for trained welders but rather one in which theory and techniques will be discussed to the advantage of those who have a concern with production problems.

The subject matter of the course will include the following: Welding Methods and Equipment; Weldability of Metals; Application of Welding in Manufacturing and Construction; Speeds and Costs; Welding Technique; Distortion Control; Inspection of Welds; Automatic Welding; and Design for Welding.

Some previous experience in the field is required of registrants for this course. The instructor will be Earl A. Webber, M.S. in E.E.; Welding Engineer, The Lincoln Electric Co.

The class will meet on Fridays, 6:15 to 8:00 P.M., beginning, February 6th and ending, May 21st. The fee will be $25. Additional information about the course, The Theory and Application of Welding (VT-61), may be secured from the Division of General Education, New York University, Washington Sq., New York 3, N. Y.

1947–48 NOMINATING COMMITTEE

With the approval of the Board of Directors the President has appointed the following members to constitute the 1947–48 Nominating Committee: A. C. Weigel, *Chairman*, Combustion Engineering Co. Inc., 200 Madison Ave., New York 16, N. Y.; John D. Gordon, Progressive Welder Co., 3050 East Outer Drive, Detroit 12, Mich.; Horace Jackson, Thompson Pipe & Steel Co., 3001 Larimer St., Denver, Colo; William T. Hudson, Chicago Bridge & Iron Co., O. Box 2567, Houston, Tex.; C. P. Sander, Western Pipe & Steel Co. of Calif., 5717 Santa Fe Ave., Los Angeles, Calif.; William E. Crawford, A. O. Smith Corp., Milwaukee, Wis.; E. R. McClung, Jr., Lukenweld, Inc., Coatesville, Pa.

The By-Laws require that these names be published in the JOURNAL on or before March 1st. The Committee is required to deliver to the Secretary in writing on or before the 10th day of May, the names of its nominees for the various elected offices next falling vacant, together with the written acceptance of each nominee.

The purpose of publishing the names of the Nominating Committee in the JOURNAL is to provide every member with an opportunity to make suggestions to the Nominating Committee. To be effective it is essential that these suggestions be sent in at once as, naturally, the Nominating Committee will be required to hold early meetings in order to fulfill its duties as required by the By-Laws.

The offices to be filled are: President, First Vice-President, Second Vice-President (all for a term of 1 year), and four Directors (all for a term of three years). Present incumbents of the offices of President, First Vice-President and Second Vice-President are eligible for another term. The incumbents for Directors at Large are not eligible for re-election, according to the By-Laws, Article VIII, Section 6. The Directors at Large are selected by the Nominating Committee, with due consideration to geographic distribution.

Present officers whose terms expire next October are: President, H. O. Hill; First Vice-President, G. N. Sieger, Second Vice-President, O. B. J. Fraser; Directors: C. H. Jennings, A. B. Kinzel, C. M. Underwood, R. D. Thomas.

DEPT. OF WELDING ENGINEERING

Establishment of a Department of Welding Engineering, the first of its kind in the nation, was announced today at Ohio State University by President Howard L. Bevis.

In the College of Engineering at the University, the new department will offer undergraduate work leading to the degree of Bachelor of Welding Engineering and advanced study for graduate engineers.

A pioneer in the field of welding engineering, Ohio State's College of Engineering has offered a curriculum in this field for some nine years, as a division of the Department of Industrial Engineering.

Establishment of the division as a separate department was authorized by the Board of Trustees on the recommendation of the College of Engineering and the Faculty Council. Curricula designed to meet the demands of industry for welding engineers will be developed in consultation with leading engineers in the nation, Dr. Bevis said.

Hitherto the curriculum in Welding Engineering has been administered by the Department of Industrial Engineering and has been considered as a division of that department. The degree given formerly was Bachelor of Science in Industrial Engineering (Welding Engineering). The action of the Board of Trustees was to set up the separate department, effective Jan. 1, 1948, and hereafter the degree granted will be that of Bachelor of Science in Welding Engineering.

The decision to establish the Department of Welding Engineering brings with it several advantages: (1) It will enable more satisfactory administration of problems relating to education and research in the welding field; (2) recognition is given Welding Engineering as an entity among the applied sciences; and (3) a degree is authorized which is descriptive of the particular disciplines imposed in training men for professional work in the field.

It is contemplated that there will be a steady increase in the facilities available within the Department for teaching and research.

AMERICAN METALLIZING CONTRACTORS ASSOCIATION

Another step in the growth of a rapidly expanding organization was signalized by the issuance of a charter from the State of Illinois to the American Metallizing Contractors Association on Dec. 29, 1947.

The founding of the new organization, to be known as A.M.C.A., was the culmination of a meeting between representatives of eight of the country's largest Metallizing Contract Shops at St. Louis, Mo. on Dec. 5 and 6, 1947.

As stated in the Articles of Agreement, A.M.C.A. was formed for the following purposes:

"To promote the welfare of the Industry and the interest of the public in matters pertaining to the Metallizing Industry.

"To foster, through lawful educational methods, mutual relations of trust, understanding and cooperation among the members of the Industry and between the Metallizing Industry and other Industries which it serves.

"To collect, preserve and disseminate lawful statistical information pertaining to the Industry.

"To exercise its powers for scientific and educational purposes, but not for pecuniary profit in any form."

Among its more important functions is that of acting as a central clearing for technical information concerning applications and the techniques employed. Such information is to be distributed to all member organizations. This interchange of data is expected to speed the growth of the process, raise its standard of quality, eliminate costly duplication of research, and expand its uses.

Through the formulation of a set of minimum standards governing various applications of the metallizing process, a uniform quality of workmanship and serviceability of the application will be maintained. Rigid adherence to these minimum standards are a qualification for membership in the organization. Thus, it is hoped to increase industry's confidence in the metallizing process.

The following officers were elected for the ensuing year: President, William Fatka, president of Metallizing, Inc., Chicago, Ill.; Vice-President, H. W. Moore, vice-president of Alloy Welding & Manufacturing Co., Tulsa, Okla.; Secretary-Treasurer, Walter B. Meyer, manager of Metallizing Division, John Nooter Boiler Works Co., St. Louis, Mo.; Chairman, Board of Directors, Thomas H. Lufkin, supervisor of metallizing, Tranter Mfg. Co., Pittsburgh, Pa.

All communications to the organization should be addressed as follows: Walter B. Meyer, Secretary-Treasurer, American Metallizing Contractors Association, 773 Brownell Ave., St. Louis 22, Mo.

THE WELDER

He stood at his bench, and struck the arcs
To the silent, cold, hard steel;
With a firm hand's clench, amid the sparks
He fashioned each plate with a zeal.
The weeks passed on, with each month in turn,
Years died, again and again;
Though time was gone, there dwelled a yearn
In his heart to be welding men.

The war now ended, and the need was gone
For his sturdy, armored plates,
But in their stead appeared a dawn
Of multitudes of hates.
What could he do since that skillful hand
Was useful no more as then?
How could he fuse Democracy's stand
For the world, in the lives of men?

He stood by his flag, and lo, an arc
Illumined a greater goal;
He nurtured a faith in that mighty spark
As it fostered humanity's role.
Time went on, at its rhythmic gait,
The Artificer worked as when
Some unit had waited his worthy plate,
Except—he was welding MEN.

GUY R. UPLINGER, Hollywood, Calif., December 1947

ANNUAL MEETING
PHILADELPHIA, OCT. 18–22

BOARD OF DIRECTORS MEETING

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held on Dec. 16, 1947, at the Hotel New Yorker, New York City.

The meeting was called to order by President Hill at 9:50 A.M. with the following present:

Members: C. A. Adams, D. Arnott, D. H. Corey, R. S. Donald, O. B. J. Fraser, H. O. Hill, G. O. Hoglund, T. M. Jackson, C. H. Jennings, A. B. Kinzel, C. I. MacGuffie, J. F. Maine, H. W. Pierce, G. N. Sieger, J. B. Tinnon, R. D. Thomas, G. M. Trefts III and A. C. Weigel.

By Invitation: E. V. David, Chairman, Convention Committee.

Staff: J. G. Magrath, Executive Secretary, M. M. Kelly, Secretary, W. Spraragen, Editor, THE WELDING JOURNAL, and S. A. Greenberg, Technical Secretary.

Finances

Report of financial operations for the fiscal year ended Sept. 30, 1947, was highlighted by the Treasurer. In particular, attention was drawn to excess income over expense of $5500 at the close of the fiscal year, despite fears that the year would end showing a red figure. This was due in part to some savings in actual operation and to the fact that we fared better than anticipated on advertising and other JOURNAL items, and on the 1946 Annual Meeting. Attention was drawn also to improvement in cash position, net worth and the combined resources of the SOCIETY this year, compared with a year ago.

Upon motion, duly seconded, report on financial operations of the Society for the fiscal year ended Sept. 30, 1947, was accepted with thanks. Mr. Fraser offered a vote of thanks to the Assistant Treasurer for the assistance given him during the past year.

1947–1948 Budget.—Copies were distributed in advance of the meeting. The Chairman explained that this budget is the result of careful study of last year's operations and anticipated income and expense for the ensuing year. In its preparation, his Committee had the guidance of the Executive Secretary, Assistant Treasurer and other staff department heads, as well as of the SOCIETY's auditor. Allowances are made for improving Headquarters' facilities, a larger traveling expense than anticipated for visitation of Sections, promotion and education programs, servicing of Sections, and other increased costs of office rental, publications, Annual Meeting and overhead.

Since careful study showed no place for reduction on the expense side without curtailment of activity, it was necessary to look elsewhere for possible sources of increased revenue that would enable the balancing of the budget. Inasmuch as the budget already provided for a $4000 increase from JOURNAL advertising, some allowances for sale of *Welding Metallurgy* book and the third edition of the *Welding Handbook*, which will be on sale this year, the Finance Committee looks to membership dues for additional support required. An estimate of $23,600 (net) was made. This amount is over and above the normal increase in membership dues anticipated and provided for in budget under regular membership dues.

In response to question as to number of members required to meet the estimated $23,600, Mr. Magrath expressed the belief the amount is attainable if a comprehensive program of activity, to be outlined later in the meeting, is carried on with the full cooperation of the Membership and other Standing Committees, as well as the Section and National Officers.

On THE WELDING JOURNAL, Mr. Spraragen explained that the increased JOURNAL income, resulting from increased advertising rates effective this year, is offset by the recently authorized payment of agency commission and the 2% returns on cash payment. He reported that since the preparation of the budget, he had been apprised by the printer of THE WELDING JOURNAL of an uprise in publication costs of the order of 19½%, but that he hoped to reduce this to 12% which in money is approximately $5000. Since one of the rules of procedure for publication of the JOURNAL prohibits exceeding the budget allotment by more than 5%, his efforts will be to reduce the JOURNAL size.

Upon motion, duly seconded, it was voted to approve the budget for the fiscal year commencing Oct. 1, 1947, as recommended by the Finance Committee, and furnished with the agenda of this meeting.

Subscription to Welding Research Council.—On recommendation of the Finance Committee, it was, upon motion, duly seconded, voted to approve the continuation of the annual subscription of $250 to WRC.

Engineering Societies Library.—On rec-

INDEX TO ADVERTISERS

Air Reduction Sales	Outside back cover	The Linde Air Products Company	99
Alloy Rods Company	149	P. R. Mallory & Co., Inc.	151
American Brass Company	Inside back cover	Metal & Thermit Corporation	Inside front cover
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American Optical Company	173	National Cylinder Gas Company	160 & 161
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Welded Design Cuts Costs 20%, Improves Saleability

By Louis E. Kibler, Engr.
A. K. Robins & Co., Inc.
Baltimore, Md.

THE urgent need for hard-to-get parts used in the conventional construction of the "goosenecks" for our food conveyors prompted us to redesign them to an all welded steel construction. The new design has netted us savings of 25% in fabricating time and of 20% in material costs. (Fig. 1.) Furthermore, the appearance of the finished machine has been enhanced considerably and the weight reduced 92 pounds, improving its saleability.

The original design of "gooseneck" involved an assembly of three separate parts bolted together. (Fig. 2.) The parts had to be milled, drilled and then tapped. The assembly also required careful matching and fitting of each side frame unit before bolting the parts together.

Our new welded design eliminates the need for any jigs or fixtures. In place of the former "gooseneck" component parts, the new design specifies 3/16" steel plate sheared from stock to any desired angle and size to comprise the side frame sub-unit. The angle iron tracks and guides are welded to the side frame and then notched. The tracks and guides are bent to the required angle to conform with the shape of the steel plate, clamped into position and welded one piece at a time with a Lincoln "Shield-Arc Jr." D.C. welder and "Fleetweld 37" electrode. (Fig. 4.) In the "gooseneck" assembly alone, the weight has been reduced from 67½ to 44½ pounds.

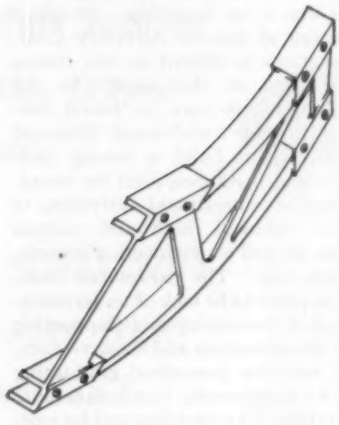

Fig. 2. Original "gooseneck" assembly. Weight 67½ lbs.

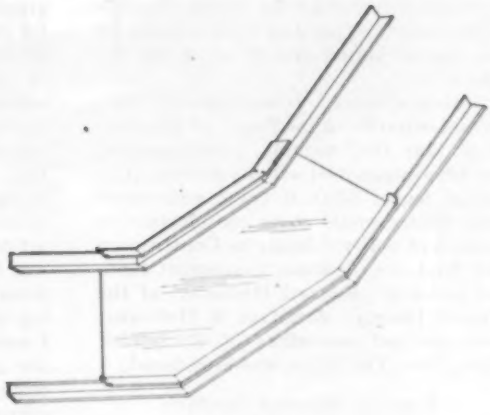

Fig. 3. Redesigned "gooseneck" of arc welded parts. Weight 44½ lbs.

An additional sales advantage of the welded conveyor is the fact that we can now match the customer's needs more readily by supplying any size or angle of "gooseneck." In our previous design little change in detail could be accommodated without involving a prohibitive expense.

To gain the same advantages on other sub-units of our conveyor the tanks, frames, drive pulleys and brackets have also been converted to welded design.

Fig. 1. All welded design food conveyor for the canning industry.

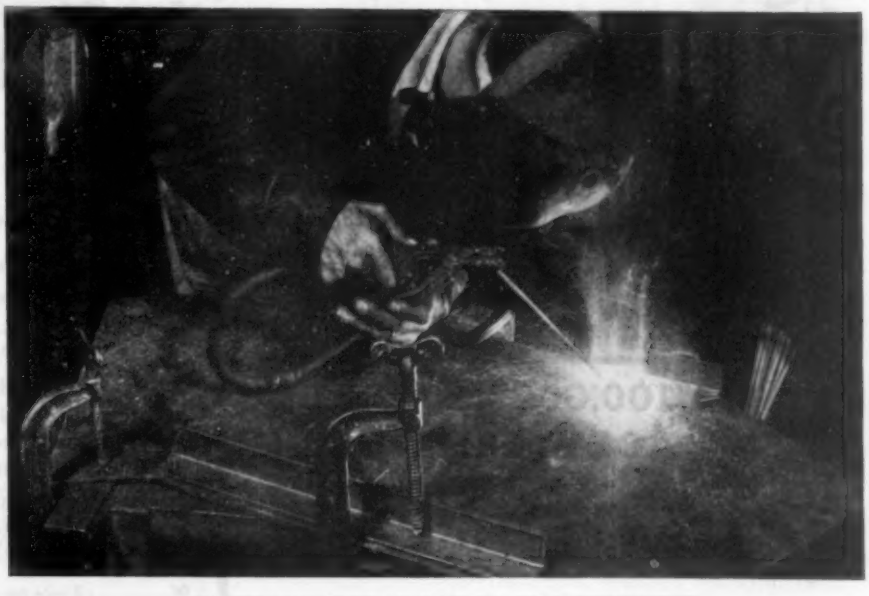

Fig. 4. Arc welding the guides to the side frame plate.

The above is published by LINCOLN ELECTRIC in the interests of progress. Machine Design Studies are available to engineers and designers. Write The Lincoln Electric Company, Dept. 102, Cleveland 1, Ohio.

ommendation of the Finance Committee, it was, upon motion, duly seconded, voted to approve renewal of annual subscription of $200 to the Engineering Societies Library.

Enlargement of Samuel Wylie Miller Memorial Medal Fund.—Action on the Finance Committee's recommendation for building up the Miller Memorial Medal fund was deferred for the present because of the SOCIETY's need of regular funds for the current actual operations of the SOCIETY.

General Counsel.—It was reported that, on authorization of the Board of Directors at its May 1947 meeting, general counsel had been engaged on a retainer basis, at an annual fee of $200, it being understood that this fee would cover consultation on matters of policy relating to Constitution and By-Laws, finances, permanent fund, and pension. Edward Holloway, of the firm of Douglas, Armitage & Holloway, attorneys and counsellors, 30 Rockefeller Plaza, New York City, was introduced.

Report of Executive Secretary on Visitation of Sections

Mr. Magrath stated that in the 15 Sections visited to date, opinion in respect to SOCIETY affairs is: 20% normal, 44% suggestive and 35% critical. By "normal" opinion is meant that they feel the SOCIETY's activities, as now executed, are satisfactory. By "suggestive" is meant that they suggest changes in and additions to many of our activities. By "critical" is meant that they feel many of our efforts are in the wrong direction, or are ineffectual, or are too conservative. It is his intention not to offer any recommendation for change in present setup and operations until he has completed his tour of the 52 Sections, which he hopes to accomplish by May 1st. The Sections are in need of guidance in their educational, membership promotion, meeting and publicity programs, as well as on financing. Proposal for expansion of Section Advisory Committee functions is offered as one means of taking care of this need. In the smaller Sections, it may be found necessary to provide additional financial aid to help them build a strong Section. In some instances, need for broadening scope of educational activities, to provide for technical, high and manual art schools, as well as engineering schools, was brought out. The paramount issue, however, appears to be lack of understanding of present Sustaining and Supporting Company classifications and requirements; the great need for prescribed graduating requisites for membership to accommodate everyone interested in welding and for suitable membership promotional literature for the various occupational groups. Knowing how this lack is retarding membership sales, and not finding that the Special Committee on Membership Requirements had as yet rendered its report, he prepared memorandum on suggested membership classifications for the Board's consideration as to whether these could be submitted to the Special Committee on Requirements for Membership. Copy of the suggestions, dated Dec. 15, 1947, was distributed to the Board.

Membership Change

During the months of October and November, the membership change was as follows: Gain, 354 (1A, 114B, 237C, 1D and 1E); Loss, 247 (3A, 79B, 163C and 2D)—a Net Gain of 107. Out of the 247 loss, 197 resigned during the past two months, mostly because of change in position, retirement, death and the like. Total membership, as of Nov. 30, 1947, was as follows: 7507 (137A, 3083B, 4243C, 36D and 8E).

National Headquarters' Facilities Improvement

Consideration was given to the four-year plan of the Executive Secretary for modernizing the present room facilities to accommodate growth in SOCIETY's activities and a minimum increase in rented floor area. Floor plans and explanatory data were furnished to Board members with the agenda of this meeting. Authorization was granted for carrying out proposed first year's plan for partitioning area for the offices of Conference Room, Executive Secretary and his secretary, and the Secretary and Assistant Treasurer and her assistants, at a cost of $1000.

Year Book and Bound Volume Distribution

Request of Executive Secretary for reconsideration of charging for these two

SPECIAL PURCHASE
SAVE 50% AND MORE
on factory list prices

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Industrial Air Products Co.
3200 N. W. YEON AVE.
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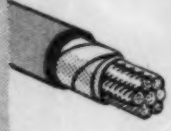
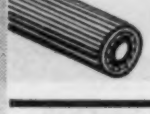
250,000 ft. Anaconda No. 1 WELDING CABLE



Made to provide utmost flexibility and conductivity. Tough vulcanized live-rubber jacket.

100,000 ft. of 5/16 I.D. ACETYLENE HOSE



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● DOCKSON cover-spectacle goggles are hard to beat. Designed for maximum comfort and ample ventilation, they are light weight, non-fogging and sturdy.

Replaceable lenses to your specifications, permit wide vision range. Rigid brace bar allows easy adjustment and convenient raising and lowering with one hand.

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Want to Weld Aluminum?

...or other "difficult" metals such as magnesium, stainless steels, copper alloys, Fernico, Inconel, etc.

Want fast, fine-looking welds with minimum distortion . . . free from oxidation . . . and without flux?

Want to conserve tungsten . . . save gas...use less power?

THIS NEW GE INERT-ARC WELDER IS BUILT FOR YOU . . . COMPLETE . . . COMPACT . . . CONVENIENT

THIS NEW Type WP Inert-Arc welder is a completely self-contained power unit. Built into this single, compact welding set are: welding transformer—control panel—capacitors for power factor correction—a bank of series capacitors to stabilize the arc—a pilot spark circuit, which operates for only a fraction of a second during starting of the arc, thus eliminating objectionable radio interference during welding—and automatic water and gas solenoid valves.

The entire assembly is enclosed in a sturdy, drip-proof case, with electrical terminals brought out to convenient outlets. Welding current is controlled to any desired setting by turning a handle on top of the welder. An indicator scale on the front of the case shows the current setting. An "off-on" switch, mounted on the welder, makes it convenient to shut down the set when the job has been completed. A three-wheeled running gear, to make the set easily portable, is optional.

After initial adjustments have been made, all components of the welder are operated (through a control panel built into the set) by means of a simple foot-treadle switch supplied with the welder. This switch enables the operator to start or stop the current to the electrode holder—purge air from the gas hose and electrode nozzle prior to welding—change electrodes or electrode adjustment, when necessary, without current to the electrode holder and without entirely shutting down the machine. Use of the foot-treadle switch also permits gas and water to flow in order to let the hot tungsten electrode cool off without oxidizing. An automatic crater filler is optional.

For more detailed information about the Inert-Arc process and the new Inert-Arc welder, see your G-E Welding Distributor. Or write for G-E bulletin GEA-4704. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

items was considered by the Board and it was, upon motion, duly seconded, voted to rescind action taken at the May 16, 1947 meeting of the Board, authorizing a charge of $2 for the Year Book and a charge of $12.50 on the year's bound volume of THE WELDING JOURNAL to Sustaining Members.

Further, it was voted to request the Special Committee on Membership Requirements to consider carefully feasibility of continuing practice of giving these publications as membership inducements in the future.

Further, it was recommended that a sticker, stating that the 1948 Year Book is available on request, be affixed to announcement in the next mailing to the membership and, in future, that such statement be made on annual dues billing to the membership.

Changes in Standing Committee Personnel

The following changes in committee personnel, approved by the chairmen of the committees concerned and by the President of the SOCIETY, were confirmed by the Board:

Additions

Educational Committee: F. J. Mooney, A.W.S. (Secretary); R. W. Clark, General Electric Co., Schenectady, N. Y.; W. F. Hess, Rensselaer Polytechnic Institute, Troy, N. Y.; H. F. Reinhard, Union Carbide & Carbon Research Labs., New York City; G. N. Sieger, S. M. S. Corp., Detroit, Mich.; A. B. Wrigley, State Supervisor, Vocational Education for New Jersey.

Publicity Committee: R. Hoagland, Westinghouse Electric Corp., Buffalo, N. Y.

Convention Committee: M. M. Kelly, Secretary of the Committee; J. G. Magrath, member, by virtue of office as Executive Secretary.

Manufacturers Committee: E. C. Smith, National Electric Welding Machines Co., Bay City, Mich.

Public Relations Committee: E. C. Smith, National Electric Welding Machines Co., Bay City, Mich.

Membership Committee: W. B. Browning, The Linde Air Products Co., Birmingham, Ala.; J. Donovan, Artisan Metal Products, Inc., Waltham, Mass.; W. T. Hudson, Chicago Bridge & Iron Co., Houston, Tex.; D. B. Hunt, D. B. Hunt Welding Engineering Co., Atlanta, Ga.

Program Committee: J. G. Magrath, A.W.S.

New Appointment

Nominating Committee: A. C. Weigel, Chairman, Combustion Engineering Co., Inc., New York City; W. E. Crawford, A. O. Smith Corp., Milwaukee, Wis.; J. D. Gordon, Progressive Welder Co., Detroit, Mich.; W. T. Hudson, Chicago Bridge & Iron Co., Houston, Tex.; H. Jackson, Thompson Pipe & Steel Co., Denver, Colo.; E. R. McClung, Jr., Lukenweld, Inc., Coatesville, Pa.; C. P. Sander, Western Pipe & Steel Co. of Calif., Los Angeles, Calif.

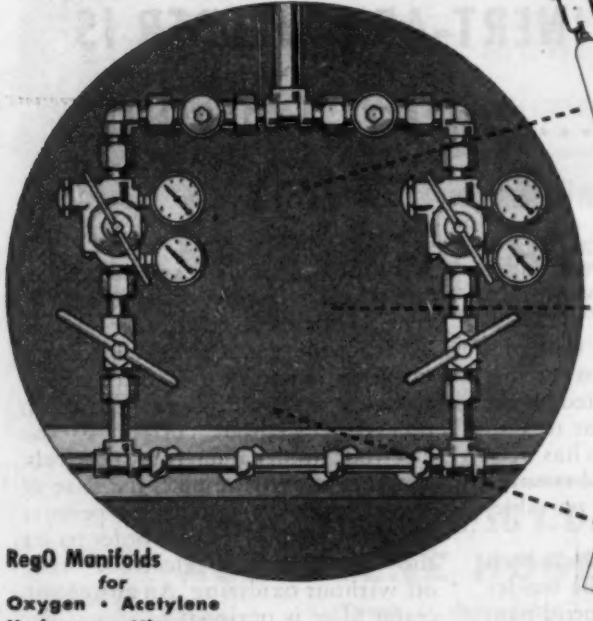
Personnel of Nominating Committee will be published in the February issue of THE WELDING JOURNAL and members will be asked to submit to the Chairman suggestions for offices to be filled in the coming election.

Reports on A.W.S. 1947 Annual Meeting and A.W.S. Participation in 1947 National Metal Congress and Exposition

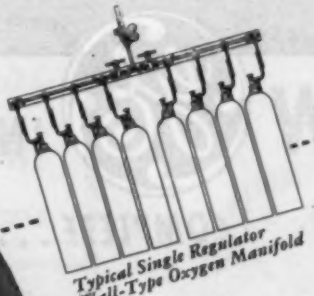
Report on technical sessions, social events, plant inspection and housing was highlighted by Chairman David. He stated that the registered attendance of members and guests at the Hotel Sherman was 1250. This figure did not include A.W.S. registrants at the Metal Show. Attendance at the Annual Dinner was 350, and at the President's Reception, approximately 250. The number of registrants for the two plant inspection trips totaled 124, and the number of ladies registered by A.W.S. was 52.

Mr. Tinnon furnished the following statistical data on A.W.S. participation in the 1947 National Metal Exposition: Exhibitors with displays devoted exclusively to welding, 33; exhibitors with welding as only part of display, 12; total number of square feet devoted to welding exhibitors by 45 exhibitors, 16,000; total amount paid by welding exhibitors, $28,000; A.W.S. commission on space, $7,500.

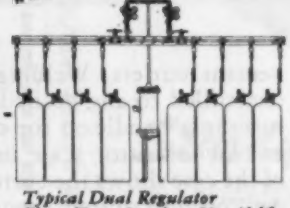
Mr. Tinnon reported that the Manufacturers Committee acknowledges the



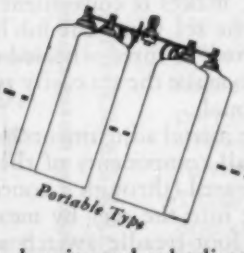
RegO Manifolds for Oxygen • Acetylene Hydrogen • Nitrogen and other high pressure gases



Typical Single Regulator Wall-Type Oxygen Manifold



Typical Dual Regulator Floor-Type Acetylene Manifold



Portable Type

REGO® CONSTRUCTION PRODUCES BETTER MANIFOLDS

● RegO design means safe performance, long life and low maintenance costs. Here are some of the construction features you get when you specify RegO Manifolds...

Unit Construction... The header section of each RegO Manifold is virtually one-piece; extra-heavy seamless brass pipe is run through the forged brass header fittings, the cylinder station shut-off valves and the master shut-off valves...all permanent connections are then silver-brazed. The header assembly is bolted to a heavy steel I-beam to assure permanent alignment.

Precision Regulation... large capacity two-stage RegOlators assure constant and uniform delivery pressure to the pipe system.

Extra Convenience... standard RegO Manifold construction provides individual shut-off valves at each cylinder station...this design permits any one cylinder to be disconnected without shutting down the entire manifold. Master shut-off valves control each main branch.

Rigid Tests... header pipe, valve bodies and fittings withstand pressure up to 10,000 psi and each complete RegO Manifold is subjected to a sustained air pressure test up to 2,000 psi.

There Is A RegO Manifold to Fit Your Most Exacting Requirements

The BASTIAN-BLESSING Company *Reg. U. S. Pat. Off.

4201 W. Peterson Avenue Chicago 30, Illinois

Pioneer and Leader in the Design and Manufacture of Precision Equipment For Using and Controlling High Pressure Gases

PERHAPS YOUR REPAIR JOBS AREN'T THIS DRAMATIC BUT...

...Read how NI-ROD* came to the rescue of a badly broken block

It looked like "curtains" for this cylinder block of a much-needed tractor motor.

Many shops might have scrapped it rather than have attempted to make repairs.

But, this shop knew about Ni-Rod.

Carefully, they fitted the fractured parts. Then, with 1/8" Ni-Rod electrodes, they welded them securely into the cast iron wall.

Result: the motor block was restored to its original soundness, the motor reassembled, and the tractor put back in service.

Of course this is an extreme case. Most of your welding jobs may not be so big... or so dramatic. But, this gives you a pretty fair idea of what Ni-Rod can do.

It may suggest how this electrode can help you repair numerous other cast iron parts.

For New Castings, too

Many automotive manufacturers today keep Ni-Rod handy to salvage damaged *new* iron castings.

For, Ni-Rod welds are high-strength, sound, machinable, and close-matching in color. You'll get smooth bead contours with Ni-Rod. Slag removal is easy. And, preheating is seldom necessary.

Take the word of scores of experienced welders: "You can't beat Ni-Rod for strong crack-free welds on cast iron."

Ni-Rod comes in 3/32", 1/8", 5/32" and 3/16" diameters. Try it yourself and see how easy it is to make on-the-spot, time- and money-saving repairs. Order a 5-lb. package from your nearest INCO distributor *today*.

*Reg. U. S. Pat. Off.

Be sure to ask for your copy of the NI-ROD instruction booklet.

EMBLEM OF SERVICE
INCO NI-ROD
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

great improvement in the Annual Meeting program, particularly as regards the quality of technical session papers, handling of arrangements of these sessions and for the time allowable on the program for visitation of Exposition.

The Program Committee was commended for its efforts to improve the character of the Annual Meeting program and on the very fine quality of papers presented at the 1947 Annual Meeting

1948 Annual Meeting Plans

Mr. David reported that, acting on invitation of the Bellevue-Stratford Hotel management, to make A.W.S. Headquarters during the 1948 Annual Meeting in the Bellevue-Stratford, the Convention Committee met in Philadelphia on November 17th for the purpose of inspecting facilities there for housing our meeting. Since available sleeping rooms in the Bellevue-Stratford could not meet our requirements, an arrangement was offered for housing the overflow in the Sylvania and Walton hotels, nearby. Through such arrangement, combined sleeping rooms placed at A.W.S. disposal total 817—140 being single rooms, 550 twin-bedded, 100 double and 20 suites. On or about March 15th, hotel reservation cards will be sent to the A.W.S. membership. The Walton Hotel is being renovated and it is expected that all three hotels will be in good condition at time of our meeting. Meeting and committee rooms, registration quarters and other public space in the Bellevue-Stratford appear to be most satisfactory. Accordingly, the Bellevue-Stratford was selected as A.W.S. Headquarters and the Sylvania and Walton hotels were selected to house A.W.S. members and guests who cannot be accommodated in the Bellevue-Stratford.

Mr. David acknowledged the fine spirit of cooperation displayed by the Philadelphia Section. Another meeting of the Committee is scheduled for January 16th to lay plans for handling the detail arrangements of the Meeting.

Mr. David was thanked for this progress report.

Establishment of Policies

(*a*) On question raised regarding use of SOCIETY emblem on letterhead of members, private or company, the Board ruled against such use of the SOCIETY emblem.

(*b*) On ethics of using letterhead of company for correspondence relating to SOCIETY activities, the Board took no action because of difficulties involved in imposing restriction on members who are giving freely of their time to SOCIETY affairs, and the difficulty of controlling the situation. It was the opinion, however, that Sections should be encouraged to have their own letterhead for the use of their officers and committees, and to have this letterhead conform to A.W.S. standard letterhead.

(*c*) The Board was sympathetic to objection raised by the Milwaukee Section to letter sent to Sustaining and Supporting Companies appealing for the enrollment of an additional Sustaining Member, which letter was sent out by the President with authority of the Board of Directors. The point made by the Milwaukee Section was that the Sections should have been consulted in advance of the sending of the letter, so as to avoid conflict with Section promotional plans. It was agreed, in future, that this procedure should be followed.

Rules Governing 1948 RWMA Prize Contest

In line with recommendation of the 1947 RWMA Jury of Award, that rules governing the RWMA Prize Contest be revised to state that when an author submits a paper he should certify that the paper submitted has not been presented before any society, or published in any periodical, or offered for publication, prior to entrance in the contest, the Board voted approval of revision as quoted below:

"To be eligible, author must indicate paper has not been considered previously in the contest, or shall not have been *presented* or published elsewhere prior to its appearance in THE WELDING JOURNAL."

Before the rules are duplicated and distributed, approval by donor and Jury of Award of the amendment will be obtained.

Welding Interest in Japan

Mr. Pierce, who just returned from a mission in Japan, told of the eagerness of the Japanese naval officers, with whom he had contact, to advance their welding knowledge. They were most appreciative of the publications received from A.W.S. and WRC, and Mr. Pierce thanked Mr. Spraragen for his cooperation in getting the publications to him on time.

National

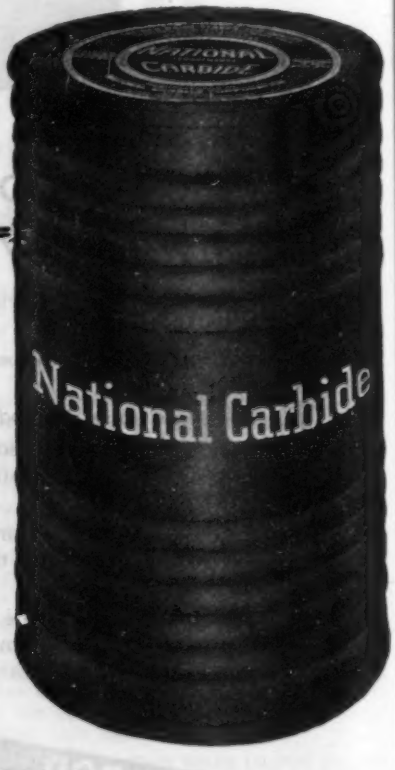
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE



FOR WELDING and CUTTING

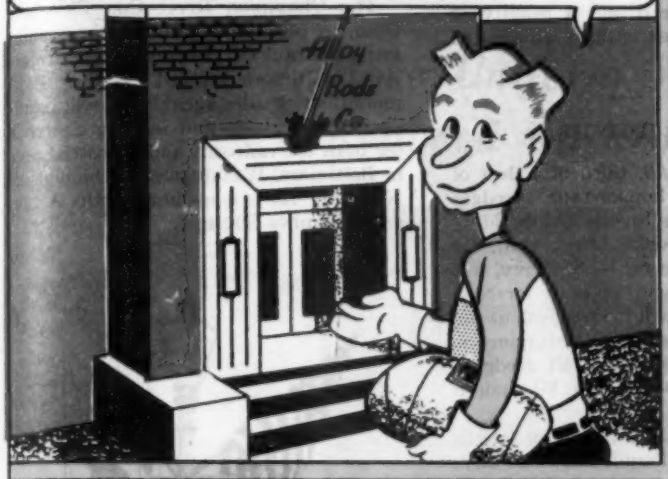
Use National Carbide in the Red Drum

Write us for information as to nearest available stock.

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York 17, N. Y.

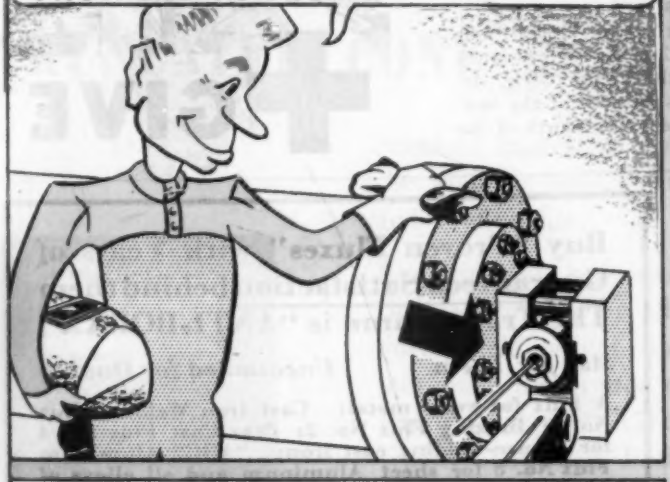
SPARKY learns about WELD-ARC 6015

SAY, HERE'S WHERE WELD-ARC LOW HYDROGEN ELECTRODES ARE MADE. I'M GOING TO SEE HOW IT'S DONE.

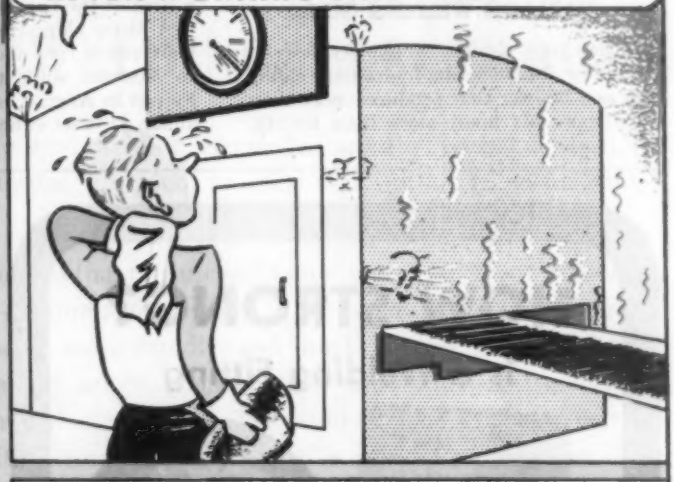


HERE'S A CLUE. INGREDIENTS IN COATING MIXTURE ARE CAREFULLY SELECTED FOR LOW HYDROGEN CONTENT.

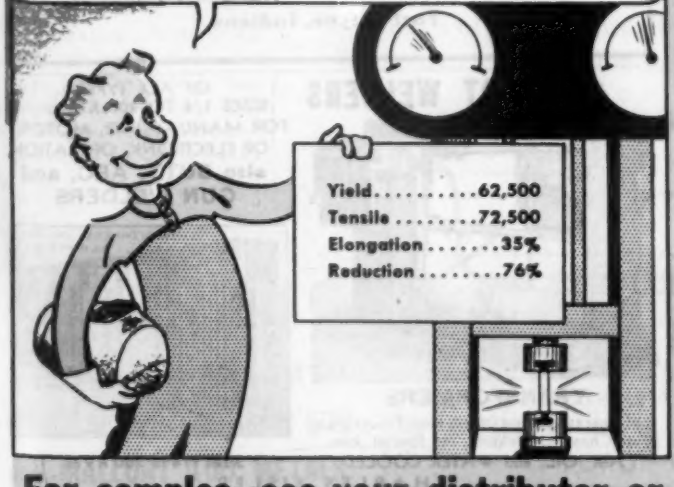
MMM—EXTRUDED, TOO. THAT MEANS WELD-ARC'S COATING IS CONCENTRIC WITH THE CORE WIRE AND UNIFORM FROM END TO END.



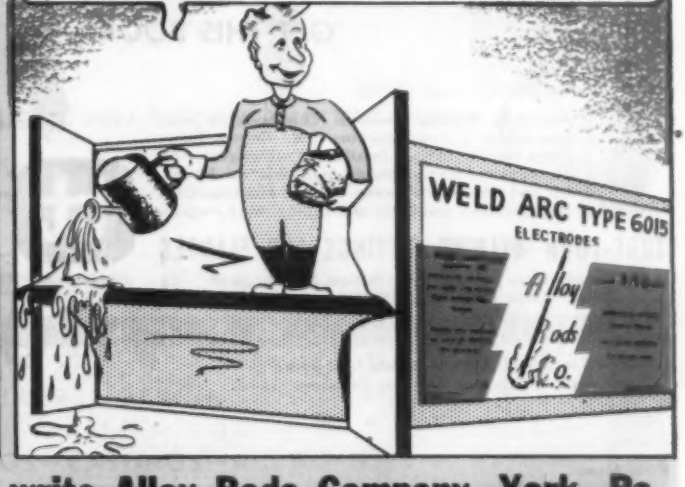
WHEW! THERE CAN'T BE ANY MOISTURE (HYDROGEN) LEFT IN THE COATING AFTER A BAKING LIKE THIS.



...AND TENSILE TESTS OF THE WELD DEPOSIT!!! NO WONDER WELD-ARC'S A BETTER ROD.



MOISTURE-PROOF PACKAGES—THAT SETTLES IT! THESE WELD-ARC ELECTRODES STAY LOW IN HYDROGEN.



For samples, see your distributor or write Alloy Rods Company, York, Pa.

Returns to Sections on Membership Contributions

Board ruling was sought on proper return to be made a Section on dues collection from a Supporting Company that pays $100 per annum for enrollment of two or three members, with dues totaling $45, and makes a contribution of the balance. The Board ruled that the Section securing the $100 payment in dues from a Supporting Company is entitled to a 20% refund on the $100 payment.

Revised Canons of Ethics for Engineers

Copy of the revised edition and memorandum, dated Dec. 5, 1947, relating thereto, were furnished with the agenda of this meeting. It was pointed out in the memorandum, it is the recommendation of the Committee on Code of Principles of Conduct that the revised draft, submitted by the Engineers Council for Professional Development, covers substantially the same ground as the Canons adopted by A.W.S. Board of Directors on June 20, 1946, but with modification of the arrangement of items and phraseology.

On recommendation of the Committee, the Board adopted the revised "Canons" to replace those adopted at the June 20, 1946 meeting of the Board of Directors.

CATALOG WELDING GUN

A four-page catalog completely describing a new double-acting hydraulic welding gun and booster that produces more than 3000 spots per hour, more than 100,000 from one point, has been released by Dalhart Engineering and Manufacturing Co., 14827 E. Jefferson Ave., Detroit 15, Mich. Besides showing blueprints of eight typical designs of guns that may be adapted to a wide variety of work and various thicknesses of metal, it includes a sectional detail of the "Booster" that makes practical this remarkable speed and a quality of weld that has almost entirely eliminated rejects.

WELDED DREDGES

The dredge *Langfitt*, third of a fleet of four ocean-going hopper-type dredges being built by The Ingalls Shipbuilding Corp. at its Pascagoula, Miss., yard, for the Corps of Engineers, U. S. Army, left the Gulf Coast shipyard recently for New Orleans, where she will be assigned to the District Office of the Corps of Engineers. The *Langfitt* will take over all dredging operations at the mouth of the Mississippi River.

The dredges measure 352 ft. in length and are powered and equipped to go anywhere in the world at a speed of 13 knots with the suction hoppers loaded to 3000-cu. yd. capacity. They are the largest all-welded craft of their type in the world, constructed by the method which was pioneered at the Ingalls yard.

A sister ship, the dredge *Comber*, was delivered in June and is at present assigned to Norfolk, while the dredge *Gerig*, delivered in August, is on duty at the Savannah District Office. The fourth of the fleet, the *Biddle*, is outfitting at the wet docks at Pascagoula. (Cover illustration.)

SWEENY APPOINTED DISTRICT SALES AGENT

The Champion Rivet Co., Cleveland, Ohio, are pleased to announce the appointment of Frank M. Sweeny of 4136 Roland Ave., Baltimore 11, Md., as their Baltimore district sales agent. He will handle the sales of rivets and welding electrodes for both the railroads and industrial users in Baltimore, Washington, Richmond and Norfolk. He is a member of the AMERICAN WELDING SOCIETY.

HOW STRONG?
is a Welding Fitting

GET THIS BOOK

Allowable Working Pressures: This book of pressure tables is a real working tool. Covers Tube-Turn welding fittings in all sizes, all weights, and all regularly manufactured materials, for Power, Oil and Chemical Process, District Heating, Gas, Refrigeration, and Hydraulic Piping. Mail coupon.

TUBE-TURN WELDING FITTINGS AND FLANGES

District Offices at New York, Philadelphia, Pittsburgh, Detroit, Chicago, Tulsa, Houston, San Francisco, Los Angeles

TUBE-TURN— *T. M. Reg. U. S. Pat. Off.*

Tube Turns, Inc., Dept. 4504, Louisville 1, Kentucky
Please send "Allowable Working Pressures" book.

Name.....
Position.....
Firm Name.....
Street.....
City.....*Zone*....*State*.....

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them
The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4 for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

ANTI-BORAX COMPOUND COMPANY

Fort Wayne, Indiana

SPOT WELDERS

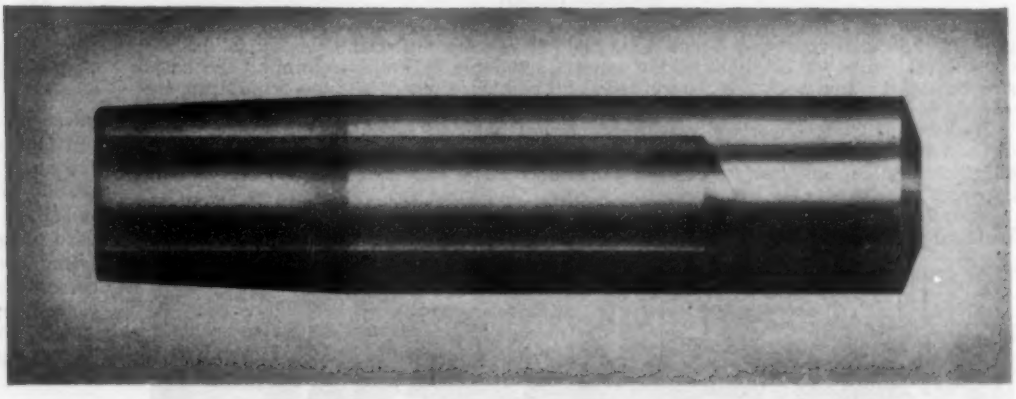
OF ALL TYPES
SIZES 1/4 TO 300 KVA.
FOR MANUAL, AIR, MOTOR, OR ELECTRONIC OPERATION,
also BUTT, ARC, and GUN WELDERS

TRANSFORMERS
For Furnaces, Lighting, Distribution, Power, Auto Phase Changing Welding, and Special Jobs.
AIR OIL, and WATER COOLED. Sizes 1/4 to 300 KVA.

CHARLES EISLER
EISLER ENGINEERING CO., INC.
779 South 13th St. (Near Avon Ave.) NEWARK 3, N. J., U.S.A.

Another NEW Product from
RESISTANCE
WELDING ELECTRODE
HEADQUARTERS...

More Uniform Welds . . . Easier Redressing . . .
Reduced Mushrooming . . . Lower Operating Cost



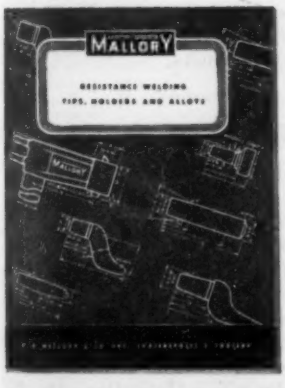
Standard

TRUNCATED CONE SPOT WELDING ELECTRODES

Standard truncated cone spot welding electrodes are the latest addition to the Mallory line—electrodes designed to give you optimum performance and weld quality.

Extensive tests have indicated that a truncated cone type of electrode possesses the ideal contour for all-around spot welding. Heat generated in the electrode during welding is dissipated more rapidly, and mushrooming is reduced to a minimum. Restoration of the original contour is a simple, low cost operation requiring very little removal of material. The welding face diameter can be readily controlled. Positive electrode alignment is a simple operation. The truncated cone type of electrode conforms to American Welding Society Tentative Standards.

This new electrode is typical of Mallory developments that have made possible much of the progress in resistance welding, and have widened the range of its industrial applications.



Information about available stock sizes of this new type of electrode is contained in the new 1948 Mallory catalog illustrated above. Write for it today.

MALLORY IMPROVEMENTS ARE AT WORK WHEREVER RESISTANCE WELDING IS!

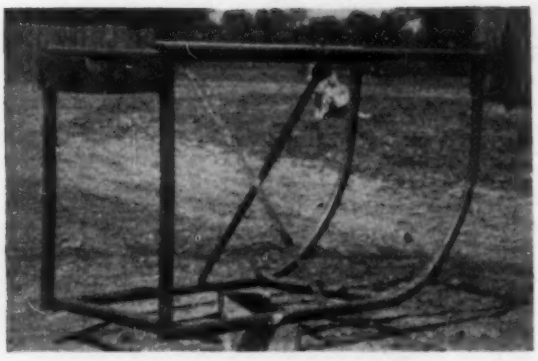
In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS, LTD. (An Associate Company of Johnson, Matthey & Co. Limited), Hatton Garden, London, E. C. 1.

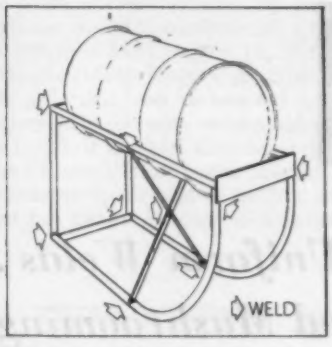
THE PIONEERS OF ELKONITE*, ELKALOY A*, MALLORY 3*, MALLORY 53B and MALLORY 100 METALS.

P R MALLORY & CO Inc
MALLORY RESISTANCE WELDING MATERIALS

ELECTRODES—HOLDERS—SPECIAL DIES AND FIXTURES—
ELKONITE* METALS—ALLOY ROD AND BAR STOCK—
FORGINGS—CASTINGS—ACCESSORIES *REG. U. S. PAT. OFF.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA





BARREL TILTER

This labor-saving barrel tilter was made by Joe Rosenstiel, Freeport, Illinois, from ¾-inch pipe, ¾-inch angle iron and 3-inch wide plate, from the scrap yard. Of course, the size of material can be varied to utilize the material available. The pipes forming the basic structure of the appliance are arc welded at all points of contact and the cross struts are welded at each end and at the crossing in the middle.

The tilter is operated vertically, with the curved members providing the rolling tilt for the bottom of the barrel. The barrel nestles between the parallel pipes seen at the top of the photo and can be tilted for emptying or filling. The tilter can be snaked around the barnyard if necessary.

From the book, "Welding Helps for Farmer", published by The James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio.

$10,000,000 VOLUME FOR LEWIS WELDING CO.

Another milestone in the growth of The Lewis Welding and Engineering Co., of Bedford, Ohio, was reached in the shipment of these all-welded steel rear counterweights and hoe booms to The Thew Shovel Co., of Lorain, Ohio, one of the world's largest manufacturers of power cranes and shovels. This cargo signals the attainment of $10,000,000 in dollar volume of shipment fabricated by Lewis.

HOT-RUNNING WELDING CABLES

A new two-page bulletin entitled *Causes and Cures for Hot-Running Welding Cables and Connections* has just been issued by TWECO Products Co., Wichita 1, Kan. The article simplifies for easy understanding the arc-welding process. Individuals charged with operating and maintaining welding cables will find many helpful hints to everyday problems. Mailed free to plant managers, electricians, master mechanics, safety engineers, welding engineers and supervisors.

NEW BULLETIN ON BRONZE ELECTRODES

Welding with Ampco Bronze Electrodes, a new bulletin W-17 just issued by Ampco Metal, Inc., Milwaukee 4, Wis., contains factual information on how to weld a wide variety of alloys using bronze arc-welding electrodes. Detailed information on welding procedures and techniques is given in the new bulletin as well as a comprehensive chart listing alloy types, specifications, chemical compositions, physical properties and weldability values using various Ampco bronze electrodes.

In addition the new bulletin catalogs all grades of Ampco welding electrodes—advertised under such trade marked names as Ampco-Trode, Phos-Trode, Beryl-Trode and Sil-Trode. The Ampco line of bronze welding electrodes is the widest offered to industry, as it embodies electrodes made of aluminum bronze, phosphor-bronze, beryllium-copper and silicon bronze.

Bulletin W-17 is well illustrated with typical applications, diagrams and sketches. Copies mailed free on request.

AMSCO TOOLFACE BULLETIN

In addition to the qualities of and uses for Amsco Toolface, technical data on welding procedures and heat treating are included in Bulletin 947-W, just released by the American Manganese Steel Division of American Brake Shoe Co., Chicago Heights, Ill.

Photographs and step-by-step diagrams show how these high-speed steel welding rods and electrodes save time and cut costs in producing, altering or salvaging cutting tools and forging dies. Charts, tables and complete descriptions cover all the heat-treating processes possible, such as forging, annealing, tempering, etc.

Composed of high carbon, high chromium, high molybdenum, with tungsten and vanadium, Toolface is readily weldable and has a high degree of metal hardness to effect economies in producing composite cutting tools used on lathes, shapers, milling heads, etc., through the deposition of readily dressed cutting edges or lands on mild steel bases or shanks. It can also be used for general hard surfacing where extreme hardness and resistance to shock and corrosion are of primary importance. The welded deposits have a Brinell hardness of 575 to 675 depending on the dilution from base metal.

MUREX LTD. BOOKLET

Murex Ltd., Rainham, Essex, England, has just published a new edition of our booklet "Standard Specifications & Typical Analyses—Metals, Metallic Alloys and Carbides." This booklet has, in the past, found extensive use for reference purposes by users of Ferro Alloys and Pure Metals, Metal Powders and Metallic Carbides. It has now been brought up-to-date by the addition of new products.

THE WELDING OF PLASTICS

"Welding of Plastics," by G. Haim and H. P. Zade. Price 21 s. Published by Crosby Lockwood & Son, Ltd., 20 Tudor St., London, E.C. 4. Mr. Haim and Dr. Zade have compiled a complete survey of the theory and practice of welding as applied to plastic materials, and have produced an exhaustive picture of every known method including a great deal of original work for which the authors themselves were responsible.

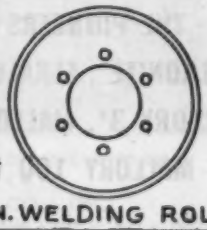
The chapters on High Frequency Heating are of particular value as they give for the first time a coherent account of the applications of diathermic heating phenomena to industrial problems. This is a book which will have a wide appeal to technicians of all classes.

"ELECTROLOY" for RESISTANCE WELDING

Butt
Flash
Spot
Seam
Projection

ELECTROLOY

Catalog and prices on request



OFFSET HOLDER

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN. WELDING ROLL

FOR SHIELDED ARC AUTOMATIC WELDING

THE NEW AND REVOLUTIONARY ELECTRODE FOR AUTOMATIC ARC WELDING

RACO Composite Type A is a heavily coated electrode in coils, providing the same physical results as heavily coated manual electrodes. With RACO Composite Type A, extremely high speeds can be obtained.

It can be used with all standard automatic arc welding heads with the addition of adapter and contact device illustrated.

RACO Composite Type A can be had with any of the following coatings—A.W.S. 6012; 6020; 6030; 7020; 7030, and corresponding high tensile grades A.W.S. 8020; 8030; 9020; 9030; 10020; 10030. This electrode can also be furnished in three grades of hard surfacing material for building-up—RACO 25 (20-25 Rockwell C), RACO 45 (40-50 Rockwell C) and RACO 55 (50-60 Rockwell C). RACO Composite Type A Electrode is furnished in the following sizes: No. 8 (approx. ⅛"), No. 7 (approx. 5/32"), No. 6 (approx. ¼"), No. 5 (approx. 7/32"), No. 4 (approx. 9/32"), and No. 3 (approx. 5/16"). Coils are 36 inches I.D., and weigh 100 to 150 pounds net.

LIGHTLY COATED AUTOMATIC ELECTRODES:—RACO Types "D", "M", M-9 (Knurled), Plain Mill Finish and Copper Coated Wire in coils.

We draw a full line of copper coated oxy-acetylene welding wires. Furnished in coils and straightened and cut lengths.

We further manufacture a complete line of heavy coated manual electrodes for welding:—Mild Steel—High Tensile Steels—Stainless Steel—Manganese Steel—Cast Iron—Nickel—Monel—Inconel and Aluminized Steel.

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The REID-AVERY COMPANY
INCORPORATED
DUNDALK • BALTIMORE 22 • MARYLAND
SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

WATER HEATER BOILER FABRICATION BY UNIONMELT WELDING

A clamping device holds the boiler shell in place while the longitudinal seam is UNIONMELT welded from the inside against a water-cooled copper chill bar. The work remains stationary while the self-propelled carriage moves the UNIONMELT UE welding head and extension through the length of the weld. Figure 1 shows the operator starting a longitudinal seam.

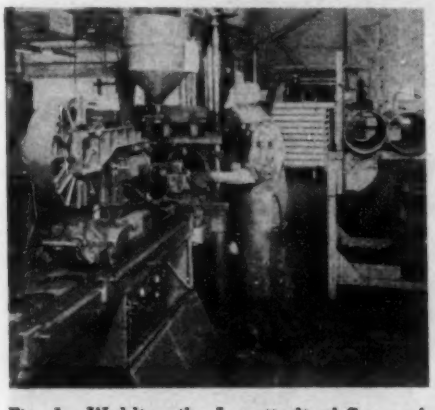


Fig. 1—Welding the Longitudinal Seam of a Water Heater Boiler

High-frequency starting and travel limit switches enable the operator to produce consistently uniform welds of high quality. The bottom and flue assembly and the head are then pressed into position into the shell and two UNIONMELT UE welding heads simultaneously join them to the shell of the water heater.

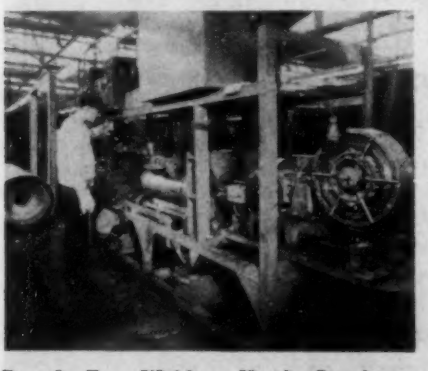
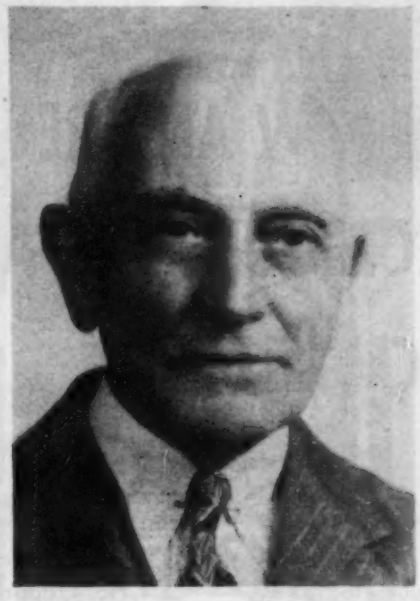


Fig. 2—Two Welding Heads Simultaneously Join the Ends to the Boiler Shell

Compressed air quickly positions the two welding heads as each heater assembly is put into the fixture. Figure 2 shows how both heads are mounted on slides and automatically positioned for welding. Welding current "ground" contact is made by the wheel dolly.

W. H. S. BATEMAN RETIRES

W. H. S. Bateman, familiarly known as "Doc" among the railroad and industrial trade retired from active business as of Jan. 1, 1948.



Mr. Bateman graduated from the Philadelphia College of Pharmacy and Science in the class of 1889. After struggling with the mortar and pestle for three years, he decided there was more excitement in the iron and steel business, and, accordingly, in 1893 he became associated with the old Lukens Iron & Steel Co., of Coatesville, Pa., now the Lukens Steel Co. Gradually, he took on additional lines of products to sell, including that of the Champion Rivet Co. Now, after more than half a century of affiliation with the iron and steel industry, he has decided to retire.

Doc Bateman is a charter member of the Railway Supply Manufacturers Assoc., and served as President during 1926 and 1928. He is an honorary member of the American Boiler Manufacturers Assoc., Master Boiler Makers Assoc., Southern & Southwestern Railway Club, Institution of Engineers in Philadelphia, Hewitt-Hausler Post Veterans of Foreign Wars, and is a member of the Veteran Corps 1st Infantry, N.G.P., U. S. Engineers Reserve Corps (Major, inactive) AMERICAN WELDING SOCIETY, National Sojourners, Thirty-third degree Scottish Rite Masons-N.M.J.

Raymond B. Johnson, who has been associated with Mr. Bateman in business for the past twenty-five years, will now become the exclusive Philadelphia district sales manager, according to T. Pierre Champion, president. The Philadelphia office will now become a direct Sales Branch office of the Champion Rivet Co.

G. E. TENNEY BECOMES SERVICE MANAGER

James F. Lincoln, president of The Lincoln Electric Co., Cleveland, Ohio, announces the appointment of G. E. Tenney as service manager to direct the policies and operations of a newly expanded Service Department. To the task of creating an organization to handle the

WELDING CONNECTORS

Saxe System Welded Connection Units for welded assembly

Saxe Units place in position and securely hold together structural parts to be welded.

As used in many welded structures they *eliminate all hole punching*, producing an economical, rigid, safe and quickly erected structural frame.

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Time Counts—
Gas cut and Weld with

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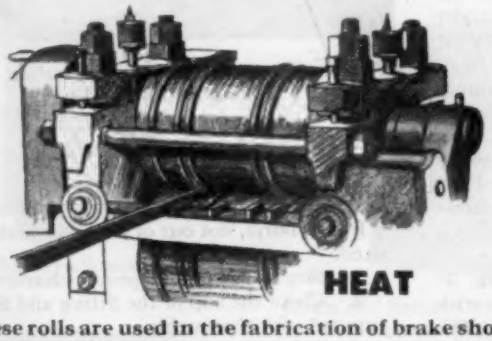
SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

HARD-FACING saves time and materials

One way to combat the present trend toward higher overhead expenses, and to ease the problem of maintaining production schedules, is to keep your machines on the job—operating efficiently—for longer periods of time. You can do this by protecting the wearing parts of your equipment with HAYNES hard-facing alloys.

Wearing parts protected by HAYNES hard-facing alloys will last up to 25 times longer, with little or no attention once they are installed. This means reduced maintenance costs and less shut-down time for repairs or replacement.

There is a HAYNES hard-facing rod for practically every condition of wear, heat, impact or severe abrasion. Illustrated here are a few examples of how HAYNES alloys are being used to save time and money. For more complete information ask for the booklet, "Hard-Facing With HAYNES STELLITE Alloys," F-2254.

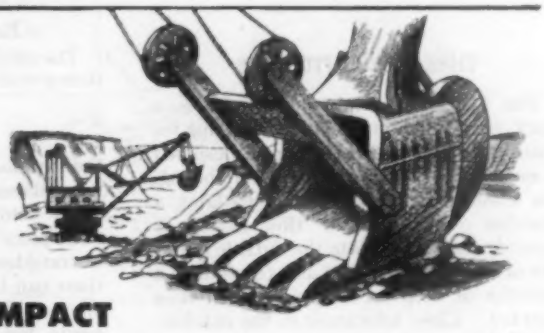


HEAT

These rolls are used in the fabrication of brake shoe keys. In operation, the temperature of the rolls is 700 deg. F.; the temperature of the work is 1700 deg. F. Before hard-facing, the rolls failed after 60,000 pieces. Since hard-facing with HASTELLOY alloy C, they have run 250,000 pieces and will probably run 50,000 more.

WEAR

HAYNES STELLITE cobalt-chromium-tungsten hard-facing rods effectively resist wear caused by abrasion, erosion, corrosion and heat. Parts such as the shaft illustrated above, last from 2 to 25 times longer when hard-faced with HAYNES STELLITE rod.



IMPACT

Parts subjected to impact, such as these dipper teeth, last from 3 to 7 times longer when protected by a coating of HASCROME rod. Moreover, parts can be rebuilt with HASCROME rod at a fraction of the cost of new parts.

SEVERE ABRASION

Drilling tools for oil fields are hard-faced with HAYSTELLITE tungsten carbide to combine maximum abrasion-resistance with superior cutting quality.

Haynes Stellite Company

Unit of Union Carbide and Carbon Corporation

UCC

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Sales Offices

Chicago—Cleveland—Detroit—Houston—Los Angeles—New York—San Francisco—Tulsa

The registered trade-marks "Haynes," "Haynes Stellite," "Hastelloy," "Hascrome," and "Haystellite" distinguish products of Haynes Stellite Company.

HAYNES alloys

TRADE-MARK

servicing of Lincoln equipment on a national scale, Mr. Tenney brings the experience of fifteen years as district manager for the Lincoln Chicago office. It was largely through the efforts of Mr. Tenney and his staff that the use of arc welding as a cost reducing production tool was greatly expanded in the industries of Chicago.

Previous to coming to Lincoln in 1932 he was the sales manager for the Moore Drop Forging Co. of Springfield, Mass., with whom he had been employed since his discharge from the Army in 1922.

At the time of the First World War, Mr. Tenney served for four and one-half years in the Cavalry and Ordnance. He was a Captain with the Coast Artillery for two years. He was graduated from the Ohio State University in 1915 with a degree of BME. Mr. Tenney is a member of the AMERICAN WELDING SOCIETY.

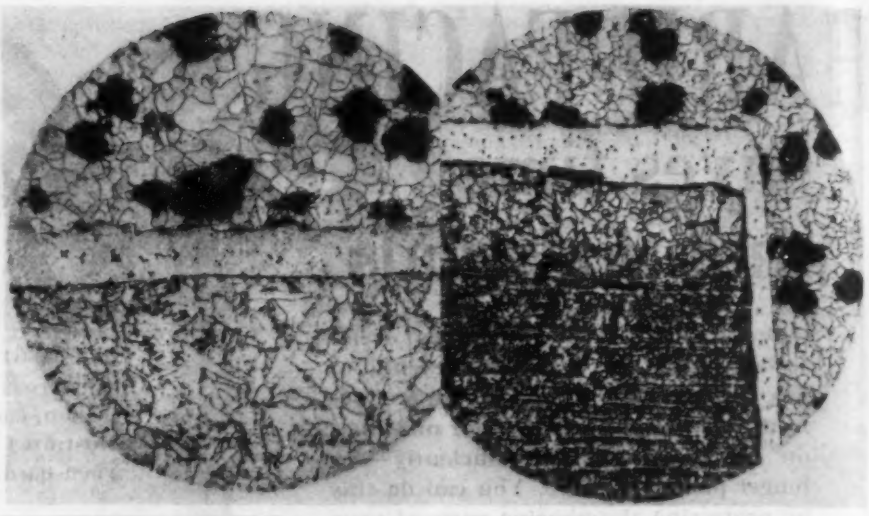

Fig 2.—No Change in Structure of Silver Brazed Joints in Malleable Iron

The picture at the left has magnification of 100 diameters; the one at the right, of 50 diameters. Both are etched in two per cent nital.

THREADLESS FITTINGS

The Flagg-Flow threadless fitting is a black, malleable iron socket-type fitting for brazing to steel or wrought iron, designed to meet the increasing demand for threadless fittings and also fittings without a chamber. The cup of this fitting is reamed to accommodate the outside diameter of standard pipe and also to produce a shoulder or stop for the pipe when it is inserted. Close tolerances in the machining of the cups insure rigid support and a thorough bond.

There is materially less pressure loss due to friction and turbulence in a piping system using these designed fittings than in a similar system using threaded fittings. This reduced loss is particularly marked when handling viscous or semisolid fluids, and the design of the fitting reduces the effects of turbulence in the pipe and fitting (Fig. 1).

Fig. 1—Tee Fitting

The fittings permit the utilization of the full wall thickness, and, therefore, the full strength of the pipe, since no metal is lost by threading. This eliminates the acknowledged weakness of a screwed pipe and fitting installation, and provides an opportunity for reducing, eventually, the wall thickness of the pipe.

One of the disadvantages of a threaded joint is that if it is improperly made, it will leak. It is also subject to corrosion, and the mechanical difficulty of joining an intricate pipe system with threads placed limitations on the use of pipe in out-of-the-way places until the advent of welding. With welding, it was possible to make a "one-piece" system without joints, which is considered ideal. Flagg-Flow connections can be made by using silver brazing alloys. These alloys are recommended for joints for industrial installations where temperatures up to 450° F. and pressures up to 300 psi. are anticipated. Black pipe and fittings are used, with the ends carefully cleaned of the coating material.

Joints made with silver brazing alloys are stronger than either the pipe or fitting, as extensive engineering tests reveal that in tension the pipe will fracture before the silver brazed joint is damaged, and under hydrostatic pressure, the pipe or fitting will rupture before the joint leaks. Similarly, under fatigue tests, failure invariably occurs in the pipe or fitting—not in the joint.

The photomicrograph (Fig. 2) of joints made between steel pipe and Flagg-Flow fittings with silver brazing alloys shows that this type of joint does not change the structure of the malleable iron.

The unretouched photograph (Fig. 3) shows physical test specimens made with silver brazing alloys. The tensile specimen pulled at 32,000 lb., which is 65,000 psi.

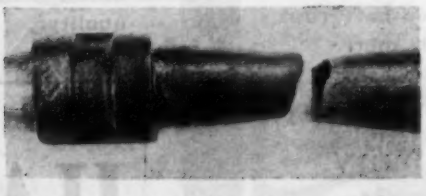

Fig. 3—Tensile Test of Brazed Joint

Silver brazing alloys melt at 1170° F. or higher, therefore an oxyacetylene torch is used to make the joint with these materials. No special equipment is required, and normal silver brazing techniques are employed. The important, but simple, steps are: Clean—Flux—Heat.

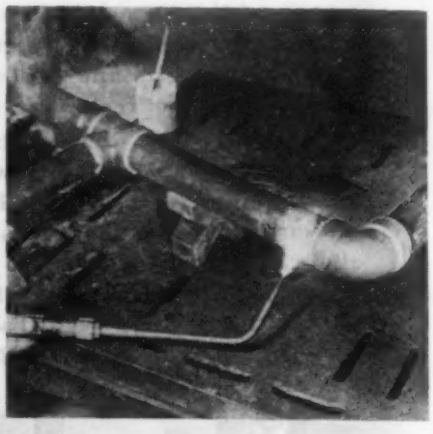

Fig. 4—Heating Pipe in Preparation of Making Brazed Joint

1. Cut pipe square. Be sure pipe end is free of burrs, not out of round or undersized.
2. Size end of pipe to proper clearance.
3. Clean the cup of the fitting and flux cup and pipe thoroughly.
4. Insert pipe into fitting hard against the bottom of the cup. Support the assembly properly.
5. Heat the pipe until the flux is "working" or bubbling (Fig. 4).
6. Switch the flame to the fitting and heat until the flux is entirely melted and fully active.
7. Apply the suitable alloy and heat both the pipe and fitting by moving flame from one to the other until the alloy flows by capillary attraction into the clearance between the cup and the pipe wall. As the alloy flows, move the flame around the fitting at the band, adding enough alloy to fill the space and to make a small fillet, if desired. Add a little heat to the pipe from time to time.

Experience has shown that in a horizontal joint, it is best to start at the top and work around. With vertical joints, the starting point is immaterial.

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on RAYTHEON WELDING CONTROLS

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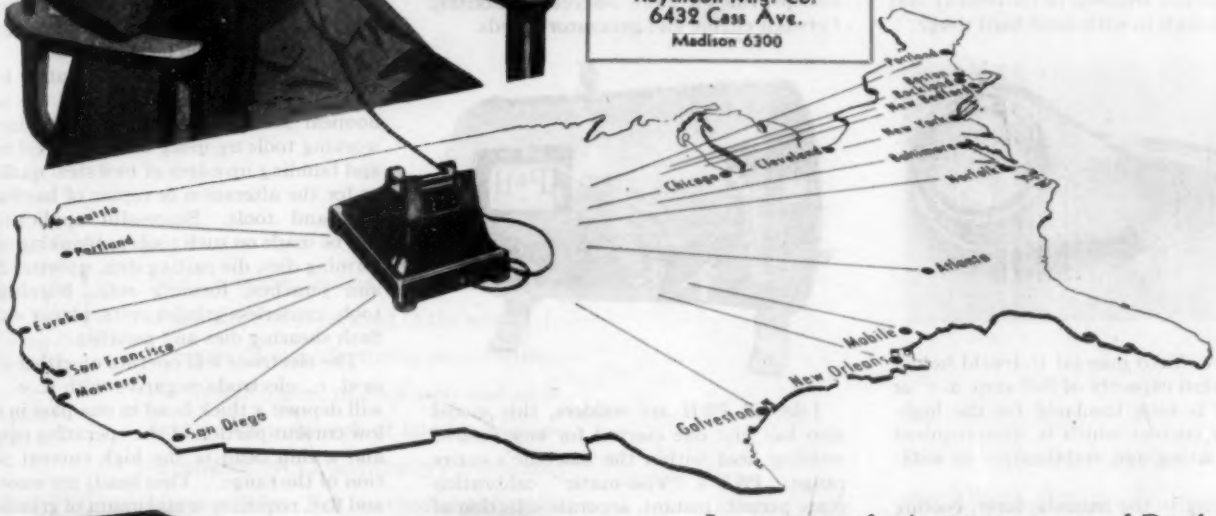
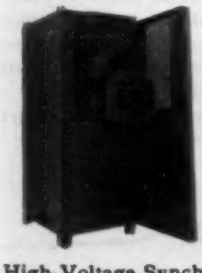
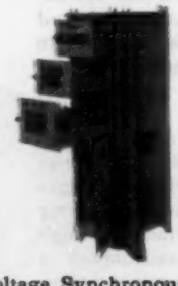


Non-Synchronous Controls

Junior and Senior Condenser Weldpower Units



High-Voltage Synchronous Controls



Low-Voltage Synchronous Controls

RAYTHEON WELDING CONTROLS built in the well-known "filing cabinet design," are flexible, easy to use, simple to service, tamper-proof and thoroughly accurate and dependable in operation.

In a matter of minutes, any user of Raytheon Welding Controls can secure authorized technical advice on his specific problem. Twenty-one Raytheon Factory Service centers, adequately staffed, are at your service.

Raytheon Factory Service representatives are thoroughly trained to provide expert aid by telephone, correspondence or field service. Even remotely located plants can be reached by air by one or more of these men in a matter of hours.

Write for detailed information on Raytheon Welding Controls

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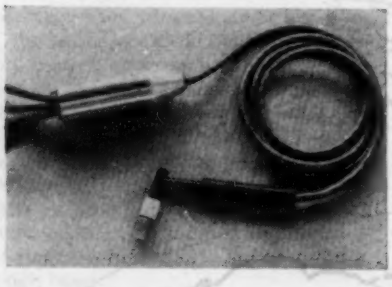
NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this section

MANUAL HELIWELD HOLDER

A new, water-cooled manual Heliweld holder has been announced by the Air Reduction Sales Company.

This new holder, designed for continuous production work with the inert-gas-shielded arc-welding method, features water cooling; an all-plastic exterior insulated for maximum protection and efficient operation; a gas cap made of nonconducting material and a light, flexible cable encased in a durable, translucent plastic cover. The holder cable is sufficiently long to permit freedom of movement and rugged enough to withstand hard usage.



The new Airco manual Heliweld holder has a current capacity of 300 amp. a.-c. or d. c. and is fully insulated for the high-frequency current which is often required for arc-starting and stabilization in welding.

According to the manufacturer, cooling of the holder is highly efficient and extends almost to the point at which the electrode is gripped. The new manual holder is approximately 10 in. long, weighs about 28 oz. and handles tungsten or carbon electrodes up to $^{3}/_{16}$ in. diameters.

For further information on the new Airco manual Heliweld holder write Dept. 1315, Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., or the Airco sales office nearest you.

AUTOMATIC WELDING TORCH

An automatic welding torch with a lever-operated built-in gas saver is announced for the user who must have both hands free occasionally to position his work. It is designed especially for production work in rapid welding of small assemblies.

Saving of gas is considerable, the manufacturer claims. The torch, when laid down while being used, goes out except for a small acetylene pilot flame. By depressing the lever when work is resumed, the operator has a welding flame ready for use without adjustment.

The torch is known as the WA-54. Also available is another model of the same torch with a lever hold-down lock for continuous welding, known as the WA-54-B.

Wall Chemicals Division of The Liquid Carbonic Corp., 3100 S. Kedzie Ave., Chicago 23, Ill.

300-AMP. GENERATOR

Deliveries of a 300-amp. bare welding generator are now being made by P&H. This unit, which has a Welding Service Range of from 30 to 375 amp., is offered to those who wish to build their own d.-c. welder. Called the Model WG-300, it is designed for easy coupling to a gasoline engine or power take-off. A V-belt pulley arrangement makes exact alignment between power and generator unnecessary, thereby simplifying the building of the welder. In addition to saving space, this also provides a more correct relationship between engine and generator speeds.

Like all P&H arc welders, this model also has just one control for any desired welding heat within the machine's entire range. P&H's "Visa-matic" calibration plate permits instant, accurate selection of the correct welding current for all classes of electrodes.

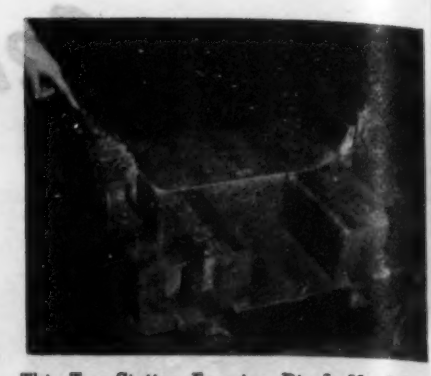
An illustrated bulletin, giving full information on the P&H WG-300 d.-c. welding generator is ready for mailing. Write the Harnischfeger Corp., Welding Division, 4400 W. National Ave., Milwaukee 14, Wis., and ask for Bulletin W33-3.

ELECTRODE FOR SIMPLIFIED HARD SURFACING OF TOOLS AND DIES

The Lincoln Electric Co., Cleveland, Ohio, announces a new electrode, TOOLWELD A&O, for hard surfacing tools and dies. The new electrode is designed to simplify procedures and reduce the cost of depositing surfaces of weld metal of tool steel quality.

TOOLWELD A&O ("A" for Air-quench; "O" for oil-quench) is for use in building up the working surfaces or edges of cold-working metal cutting and forming tools. It will produce surfaces of high strength for resisting wear and impact in all applications where high temperatures are not encountered. When deposited on either ordinary carbon steel or on any one of the hundreds of alloy steels, TOOLWELD A&O produces a surface whose properties will match those of the best tool and die steels.

The deposited weld metal is of the 5% chrome type and may either be used as welded or subjected to a wide range of heat



This Two-Station Forming Die Is Used for Forming the First Two Operations in Making Generator Housings from $^{11}/_{16}$-In. Plate

treatments. When used on ordinary steel, the weldment may be heat treated to give the maximum hardness quality in the weld. When used on tool steel, the weldment may be heat treated as is demanded by the nature of the base material.

TOOLWELD A&O is a versatile, low-cost electrode recommended for the economical manufacture of composite metal working tools by using a carbon steel base and building up edges of tool steel quality, or for the alteration or repair of hardened dies and tools. Successful applications can be made on such tools as blanking dies, forming dies, die casting dies, upsetter dies and punches, forming rolls, burnishing tools, centerless grinder rests, planer ways, flash shearing dies and punches.

The electrode will operate on either a. c. or d. c., electrode negative with d. c. It will deposit a thick bead in one pass in the low current portion of the operating range, and a thin bead in the high current portion of the range. Thin beads are smooth and flat, requiring a maximum of grinding.

TOOLWELD A&O is packed in 10-lb. containers. The following table gives sizes manufactured and their current ranges:

Electrode Size, In.	Ampere Range
$^{3}/_{32}$	40–85
$^{1}/_{8}$	65–130
$^{5}/_{32}$	95–180

LIGHTWEIGHT CUTTING TORCH

Unique at the Metal Industries Show in Chicago was Wall Chemicals Division's display of their Gasweld AV-10 lightweight welding torch with its newly developed cutting attachment. Passers-by were invited to try their own hand at oxyacetylene cutting a $^{1}/_{2}$ in. thick steel plate.

The AV-10 welding torch was originally designed for light welding, brazing and soldering jobs in the aviation industry and has been found suitable for much work of like nature in other industries. Now with the new cutting attachment it may be used also as a precision tool for occasional light cutting jobs.

Tips for the WC-10 cutting attachment

Users ALL AGREE...

To Be Sure, Say Sureweld

"Sure, Sureweld does it better, faster, easier—*every* time", say thousands of satisfied Sureweld users. They want an electrode that's dependable, and they *all agree* they can depend on Sureweld for..."Reliably Uniform Performance".

Sureweld's unvarying high quality is no accident. *Four* separate and distinct laboratories safeguard every step in the production of Sureweld electrodes—in the most modern plant of its kind in the world. The high-speed, high-precision machinery that manufactures Sureweld electrodes is without a counterpart in the industry.

Add to this the 30 years of growing up with welding in all its phases that authenticates every NCG product, and you have every reason for asking, "Can't Sureweld do a better job in *my* shop too?" Let an NCG representative or distributor prove it to you. NCG's vast network of service and supply assures you *fresh* electrodes, *promptly* delivered, whenever you need them.

NCG is recognized as one of the largest organizations of its kind in the world. It operates 73 manufacturing plants within the United States, offers supply and service by a vast network of hundreds of independent NCG distributors and warehouse stocks. For assured satisfaction in *your* welding and cutting needs...

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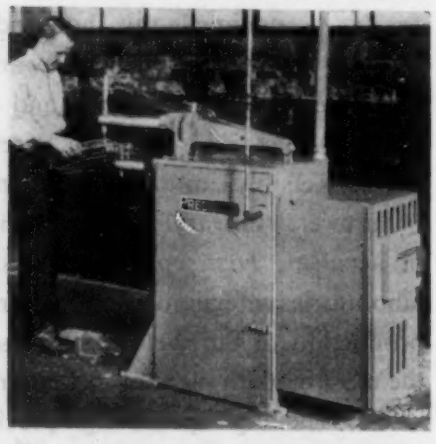
are furnished in sizes 0, 1 and 2. The No. 2 tip will cut steel up to 1 in. in thickness with ease. The cutting head is 90° and is forged brass.

With gooseneck welding tip the AV-10 torch weighs 12 oz. and is 12 in. long, while with cutting attachment installed it weighs 1 lb., 2 oz. and is 12 in. long.

Wall Chemicals Division of The Liquid Carbonic Corp., 3100 S. Kedzie Ave., Chicago 23, Ill.

WELDED FAN GUARD

A Westinghouse nonsynchronous welding control, mounted on the rear of this standard high-speed rocker-arm welder, times and sequences each weld. Functions of squeeze, weld, hold and off are calibrated in cycles. Each can be set for the job at hand by adjustment dials on the cabinet door. A feature of the control is



that the sequence timer panel is plug-connected for easy removal. Voltage regulating tubes to take care of the fluctuations found on welder circuits are incorporated in the panel. Over-all cabinet dimensions are 36 in. high, 18 in. wide and 12 in. deep.

HEATING TORCH

Over eight full hours burning time, 3800° F. operating flame, filling costs of less than 2¢, hand-size convenience—these are some of the features of the Crown Torch, completely self-contained heating torch which burns butane or propane gas.

The Crown Torch is designed for all soldering, brazing and heating operations. Uses include sealing sweat joints, lead burning, lightbrazing, radiator soldering and repairing, sealing batteries, thawing frozen pipes, paint burning, soldering of copper pipe, radio and armature repairing,

leading bodies and fenders, silver soldering, heating and bending, cable splicing, heating and forming composition floor tiles and many others.

The Crown Torch is 12 in. long, $2^1/_4$ in. in diameter, and weighs $2^1/_2$ lb. when full. Other features include fingertip control of flame size and temperature, patented "all-in-one" tip which eliminates need for tip changes, 100% Btu. efficiency, and easy filling operation. The Crown Torch can be filled from any standard butane or propane tank.

The Crown Torch is manufactured by Sully Engineering Ltd., 7416 Melrose Ave., Los Angeles, manufacturers of butane-propane equipment.

UNIONMELT AUTOMATIC FLEXIBLE WELDER

The advantages of the UNIONMELT welding process (submerged melt welding) can now be made easily available anywhere in the shop, on any work that can be suitably positioned. This is accomplished with the new UNIONMELT flexible welder, recently demonstrated publicly at the National Metals Exposition in Chicago by The Linde Air Products Co., Unit of Union Carbide and Carbon Corp.

The machine is particularly useful for making welds that are inaccessible for fully automatic welding, making short welds where it is not worth while to mechanize the operation, building up deposits of almost any size or shape and depositing metal to repair weld or casting defects. The UNIONMELT automatic flexible welder can be used as a primary welding tool in a small welding shop or as a supplementary tool for fully mechanized installations.

Fig. 1—The UNIONMELT Flexible Welder Has an Operating Radius of 20 Ft.

The special feature of this machine is that the welding nozzle, at the end of a 20-ft. long flexible hose, when held in the operator's hands, can be moved from one weld to another without stopping to set up track, carriage or other guiding equipment. The welding nozzle is easy to handle and guide along the seam or over the area to be built up.

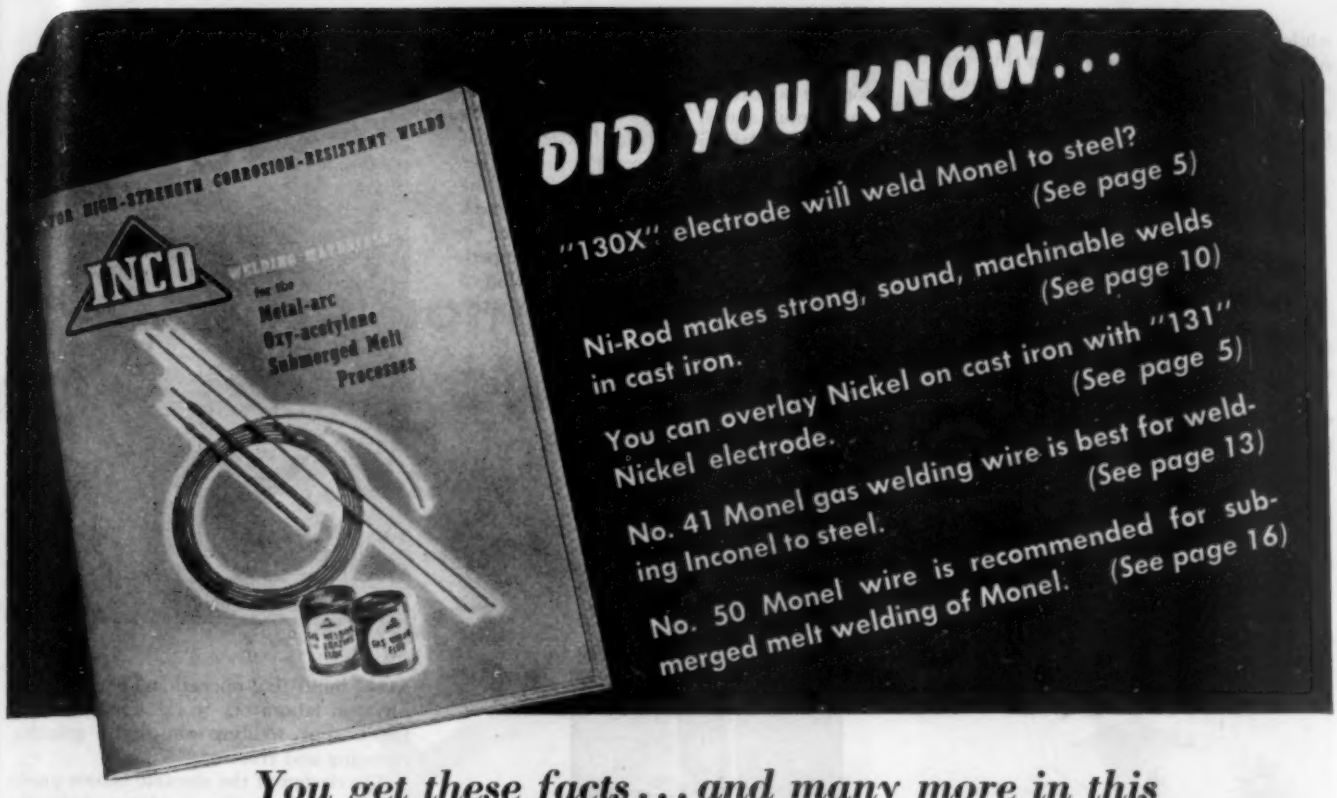
The flexible hose, connecting the nozzle to the main machine assembly, contains the welding current cable, and two tubes through which the welding rod and the granular material are fed. Bare welding rod of any size up to $^5/_{32}$ in. diam. in the standard 25-lb. coils can be used in the machine.

Fig. 2—The Unit Can Be Easily Moved to Any Desired Location. Only Three Connections Are Required to Put It in Operation

Granular welding composition is continuously supplied to the welding nozzle by compressed air from a storage tank included on the main machine assembly. This tank, holding about 75 lb. of the material, provides an adequate supply so that an entire 25-lb. coil of welding rod can be fed without interruption and without danger of flash which might occur frequently if a smaller supply were used. The granular material flows by gravity from the welding nozzle and the operator controls the depth of the layer laid down by the height at which he holds the nozzle above the work surface. Included in the main machine assembly, in addition to the tank holding the supply of granular material, are a specially adapted standard Unionmelt welding head, the control unit and a rod reel. This assembly, compactly arranged, is mounted on wheels and can be moved easily anywhere in the shop. All controls are operated from a small portable switchbox which the operator can keep with him within easy reach.

The flexible welder has a capacity of 900 amp., either direct or alternating current, which may be supplied from any welding generator or transformer. Compressed air at about 35 psi. pressure is required to force the granulated composition through the flexible tube to the nozzle. Only a small amount of compressed air is used, about 110 cu. ft. being required for each tank full of welding composition or for each 25 lb. of rod deposited. Simple external connections—compressed air hose, welding cables and a cable carrying 110-v. current and the contactor and relay operating leads for the control unit—are all that are necessary to make the unit ready for operation.

The flexible hose and cable to the portable switchbox can be coiled around the main assembly which can be easily wheeled to any desired location, or the complete assembly can be readily transported by crane. The entire unit may be operated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"130X" electrode will weld Monel to steel? (See page 5)
Ni-Rod makes strong, sound, machinable welds in cast iron. (See page 10)
You can overlay Nickel on cast iron with "131" Nickel electrode. (See page 5)
No. 41 Monel gas welding wire is best for welding Inconel to steel. (See page 13)
No. 50 Monel wire is recommended for submerged melt welding of Monel. (See page 16)

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As a further help, you'll find recommended amperages for each electrode.

If you're a gas welder, there's a section that deals with the wires and fluxes to use when gas welding Monel, Inconel*, Nickel, and steel.

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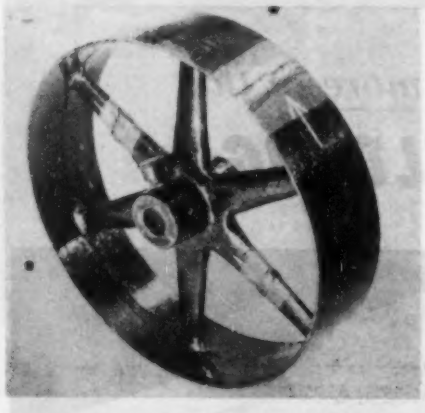
while hanging from a movable overhead support, and when supported in this way it can be readily operated over even a greater area than can be reached with the 20-ft. tube.

FLUX-COATED GAS ROD FOR CAST IRON

Designed specifically for all types of gray or alloy cast iron and to eliminate the uncertainties and delays of manual fluxing when welding stressed cast shapes, a new color-matching flux-coated torch welding rod known as "EutecRod 14 FC" has been announced by Eutectic Welding Alloys Corp. This rod develops a tensile strength of 48,000 psi. in the weld deposits, bonding at 950–1400° F., with a remelt temperature of 2200° F. Its coefficient of expansion is the same as that of gray cast iron, and its hardness is approximately 190 Brinell, producing welds that are fully machinable.



Cast Iron Pulley 16 In. in Diameter (with 4 In. Rim) Welded in 3 Highly Stressed Areas with No Distortion or Cracking, Using New Flux-Coated "EutecRod" 14FC.

The illustration is especially interesting for the number and character of welds in the stressed areas, where high heat rise accompanying ordinary torch rod applications could result in irreparable cracking and hardened areas. However, these welds were accomplished with an oxy-acetylene flame, with a slight preheat of 200°, using a No. 5 tip, which was held at a distance of $^3/_8$ in. from flame cone to surface metal. The well-known principle of flux-coating, now available for cast iron torch welds with the introduction of this new product, is said to make it possible to achieve fast, smooth welds of similar character quite easily, with very little fusion of base metal, and with correct fluxing automatically maintained at every point during the weld. All broken sections or cracks in this pulley were beveled to 75–90°, and a forehand welding procedure was used to melt the flux and filler metal, after heating the welding area to a dull red. As may be seen, no special technique is required to apply the new flux-coated rod.

For additional information, write Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y.

AUTOMATIC BUTT WELDER

Special purpose automatic butt welder for the welding of nickel ground wire to spark plug shells, has been completed by Agnew Electric Co., Milford, Mich. It is identified as the Type SPB-2. It has fully synchronous control of welding current and time. Operator places spark plug shells in indexing table. Wire is taken from the reel, fed to length, clamped, cut-off, welded to shell and the ejection of the finished part is entirely automatic.

Driven by a motorized reducer unit through an adjustable friction clutch, the machine operates as long as the foot pedal is depressed; release of the foot pedal stops it instantly. Hand operation is provided for setting up purposes and sixteen-position table for loading shells in five positions. A heavy fabricated frame completely encloses the machine protecting the operator from the shafts, cams and reciprocating parts. Guards swing out of place to make mechanical adjustments. This type of automatic butt welder can be readily adapted to high-speed welding of small parts allowing the use of unskilled operators. Type SPB-2 has a production of 3600 pieces per hour.

SAFETY GOGGLE

A new lightweight, comfortable safety goggle featuring an all-plastic frame with a single plastic acetate lens which provides maximum vision is announced by American Optical Co.

The new AO 607 safety goggle is recommended for wear directly over eyes or over spectacles for frontal protection against flying particles on jobs such as machine

work, hand tool operations, chemical and physical laboratory work, bottling operations, spot welding and light grinding, chipping and riveting.

The design of the durable brown plastic frame is such that it provides unobstructed side vision, excellent frontal protection and smart appearance. No metal touches the skin.

The single plastic acetate lens in green or white color, conforming to high safety standards, is easily replaceable.

The metal temples, enclosed in acetate to prevent corrosion, are easily adjusted and hold the goggles snugly without irritation.

Each goggle is supplied with a leatherette case.

TWECO PRODUCTS

A new 12-page TWECOLOG fully describes the complete line of TWECO welding electrode holders, ground clamps, cable connectors, machine terminals, cable splicers, lugs and carbon holders. Quantity price and parts information is included. Bulletin shows new models. Mailed free to those using the electric welding process. TWECO Products Co., Wichita 1, Kan.

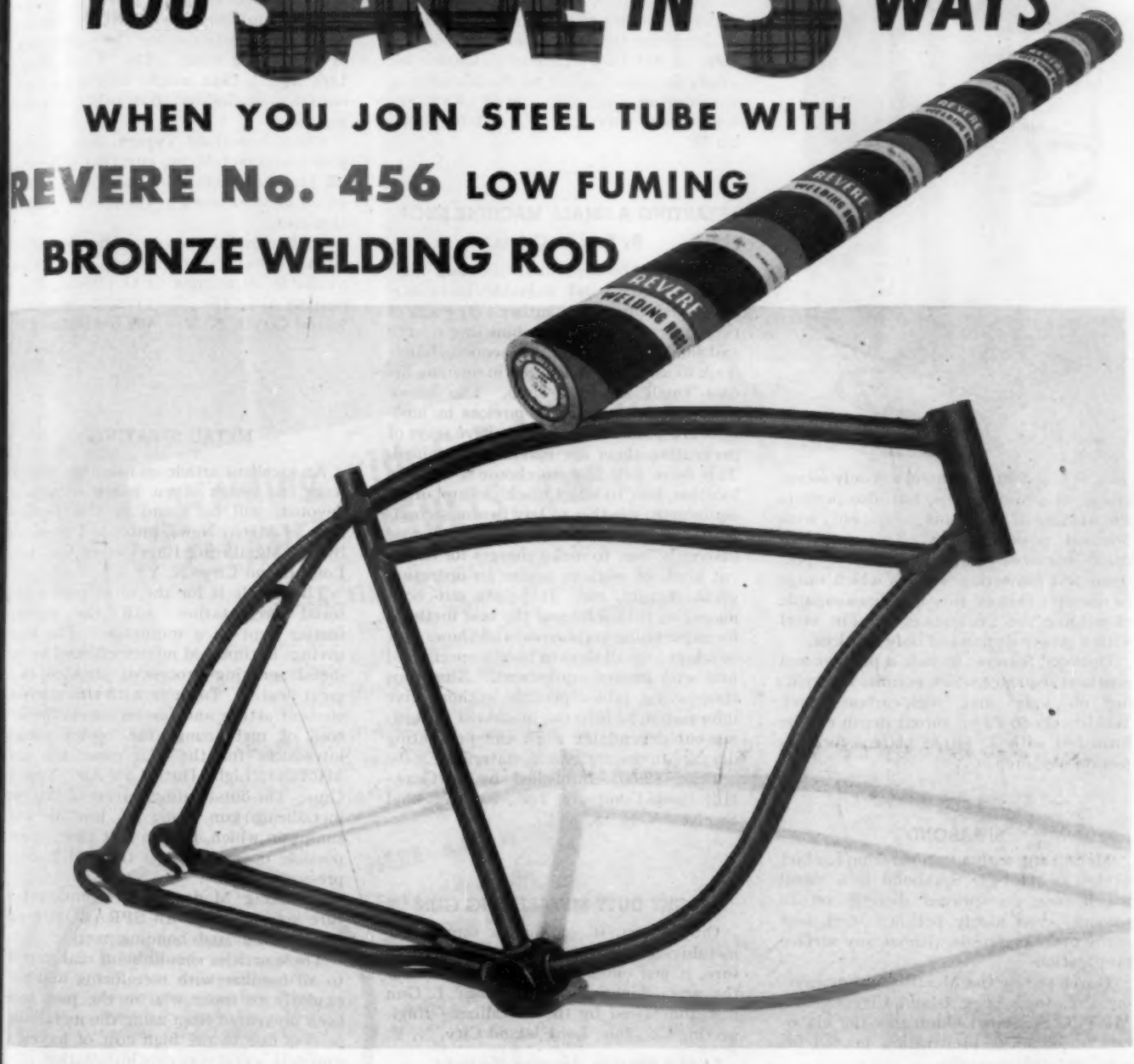
NEW SMALL WELDER NOW AVAILABLE WITH THREE-PHASE CONTROL

A new series of press-type welders has been announced by Sciaky Bros., Chicago. Utilizing a standard frame size, these welders offer a choice of 5 power ratings (20, 30, 40, 50 and 75 kva.) and 4 throat depths (12, 18, 24 and 30 in.). Capacities on mild steel range from 0.016 to 0.125 in.

If desired, the welders can be furnished with "Three-Phase." Available for the first time on small machines, this feature reduces the required power rating by 50% and operates on a *balanced* three-phase load at a power factor of 85% or better.

YOU SAVE IN 3 WAYS

WHEN YOU JOIN STEEL TUBE WITH REVERE No. 456 LOW FUMING BRONZE WELDING ROD



You make important savings at every step of the way when you join steel tube frames for bicycles, furniture, etc., with Revere No. 456 Low Fuming Bronze Welding Rod. Here's how:

1. **FASTER ASSEMBLY**—You spend less time assembling the parts to be joined, because the high strength of Revere No. 456 permits wide assembly tolerances and still provides strong, neatly-finished joints with well-formed fillets.

2. **LESS "CLEAN-UP"**—"Clean-up" costs are materially reduced, because Revere No. 456 is low fuming and thus enables you to get more accurate placement of the weld metal.

3. **REJECTIONS ELIMINATED**—Inspection rejections and failures in the field due to breakage of joints are practically eliminated.

In addition to these three direct cost-saving advantages, Revere No. 456 enables you to work in comfort with no excessive fumes, and it produces joints that are stronger than the steel tube. Try Revere No. 456 and see for yourself how you can cut costs, save time and get better results with this "flame tested" rod in the striking red, white and blue package.

Other Revere Welding Rods are: Revere Bronze 380, Manganese Bronze, Herculoy, Phosphor Bronzes, Brass (Brazing Rod), Silicon Deoxidized Copper and Electrolytic Copper. All come in 100-pound cases or in 25-pound cartons, net weight, and are stocked by Revere Welding Rod Distributors in all parts of the country. Write for folder giving technical data and net prices.

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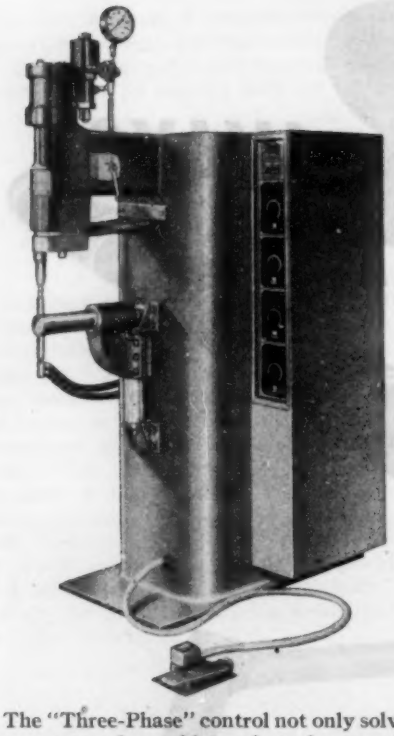

The "Three-Phase" control not only solves power supply problems, but also permits the welding of aluminum, brass, etc., with nominal power supply. This series of small machines completes a line of spot, seam and projection welders which range in size up to heavy duty machines capable of welding two thicknesses of $^5/_8$-in. steel with a power demand of only 500 kva.

Optional features include a preheat and postheat sequence which permits the welding of scaly and high-carbon steel. Welders up to 24-in. throat depth can be furnished with T-slotted platens for projection welding.

SPRABOND

Metallizing without preparation is a fact at last. METCO Sprabond is a metal which may be sprayed directly on to smooth, even highly polished steel, and many other materials without any surface preparation.

Developed by the Metallizing Engineering Co., Inc., Long Island City, N. Y., METCO Sprabond eliminates the elaborate mechanical preparation needed for good metallizing results.

With METCO Sprabond only three steps are necessary in building up a worn shaft with metallizing, as compared with eight steps necessary in the past. All the costly preparatory operations have been eliminated so that the only preparation necessary is to clean the shaft.

A bulletin has been prepared explaining in detail the time and money saving features of METCO Sprabond. Copies are available upon request to the Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y. Ask for Bulletin 57.

STARTING A SMALL MACHINE SHOP

By Fred H. Colvin*

The sound business methods, shop operating practices and valuable know-how developed during the author's 60 years of personal contact with machine shops, large and small, are offered in this concise handbook to assist the machinist in opening his own small machine shop. The many costly mistakes made by novices in business are pointed out and positive ways of preventing them are carefully explained. This book tells how to choose a suitable location, how to select machines and other equipment, whether to buy new or second-hand machines, where and how to store materials, how to make charges for different kinds of work to assure an operating profit margin, etc. It points out both managing principles and the best methods for supervising employees, and shows how to adapt a small shop to handle specialized jobs with limited equipment. Numerous time-saving tables provide authoritative information to help the machinist in turning out dependable work and preventing damage to machines and materials.

Price $2.50. Published by McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 18, N. Y.

LIGHT DUTY METALLIZING GUN

Only 10 cu. ft. of air per minute for metallizing. This, the outstanding feature, is just one of many new features of the new "Light Duty–Low Air" L Gun just announced by the Metallizing Engineering Co., Inc., Long Island City, N. Y.

* Editor Emeritus, *American Machinist*.

This new gun also boasts of new turbine construction requiring only one-third the power, making a large compressor unnecessary. The new nozzle construction assures lower cost per pound of metal sprayed because of the low consumption of acetylene and oxygen. And yet another feature—turbine control which requires only one adjustment for the entire range of metallizing wires. The "Light Duty–Low Air" L Gun weighs only 4 lb. 2 oz., considerably lighter than other metallizing guns.

These important Type L Gun features give you a metallizing gun that will spray all kinds of metals by hand or machine on all kinds of work at the lowest installation cost.

An illustrated and comprehensive bulletin has been prepared—copies of which are available on request to Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y. Ask for Bulletin 55.

METAL SPRAYING

An excellent article on machine element work, to which seven pages have been devoted, will be found in the January issue of Metco News, published quarterly by the Metallizing Engineering Co., Inc., Long Island City, N. Y.

The article is for the most part a pictorial presentation with the reading matter kept to a minimum. The large savings in time and money effected by the metal spraying process is stressed to a great degree. To tie in with this machine element article and further stress the low cost of metallizing, the center spread introduces for the first time the new METCO "Light Duty-Low Air" Type L Gun. The outstanding feature of this new metallizing gun being its low air consumption which, for the first time, makes possible operation on a three H.P. compressor.

"Bonding Made Easy"—another feature article deals with SPRABOND, the newly discovered bonding metal.

These articles should be of real interest to all familiar with metallizing and particularly to those who in the past have been prevented from using the metallizing process due to the high cost of having a complete metal spraying installation.

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"This Is Resistance Welding," G.E.'s full-color movie explaining what resistance welding is, and where and how it has improved production. Your nearest G-E office, local utility, or resistance welding machinery manufacturer will be glad to arrange a free showing for you.

For more information on these new lines of G-E welding controls, ask for bulletins GEA-4699 and GEA-4726.

Apparatus Department, Sec. M645-44
General Electric Company
Schenectady 5, N. Y.

Please send me your free bulletins on the new lines of G-E welding controls:

- ☐ GEA-4699, Synchronous Precision Controls for Spot and Projection Welding
- ☐ GEA-4726, Nonsynchronous Electronic Controls for Spot and Projection Welding

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GENERAL ELECTRIC

SECTION ACTIVITIES

CHICAGO

One of the most successful December meetings ever held by the Chicago Section, was the December 19th meeting at which Eric Seabloom, Supervising Engineer, the Crane Co., was the speaker. Mr. Seabloom discussed the metallurgy and welding of alloy steels. In an interesting illustrated presentation, which disclosed heretofore unpublished data relative to the welding of stainless and high chrome alloys, Mr. Seabloom was able to cover many interesting problems that confront the welding engineer. He also brought out as a sidelight the part that research has played in the use of welding in high pressure applications. He disclosed many interesting applications of welded piping in the power and machinery fields.

Following Mr. Seabloom's presentation there was an interesting discussion period which kept the members long beyond the usual meeting time. Prior to the meeting there was the usual get-together of many members of the Chicago Section for a period of good fellowship and food at Burke's Grille. Two interesting movies also preceded Mr. Seabloom's talk.

CINCINNATI

A joint meeting of the American Institute of Electrical Engineers, AMERICAN WELDING SOCIETY and American Society for Metals, was held on Friday, December 19th, at Engineering Society Headquarters. W. N. Parker, Radio Corp. of America, presented an address on "High Frequency Welding—A New Electronic Tool." This presentation described methods for utilizing high-frequency power for making metal-to-metal welds. Accessory equipment was fully described and shown, as well as potential applications to the automotive and aircraft industries. Actual sample welded parts were also shown.

A very interesting movie on "Railroad Signalling" was shown before the meeting. Refreshments were served after the meeting. The American Institute of Electrical Engineers was the host.

CLEVELAND

"Atomic Energy—Tool or Weapon" was the subject of the January 14th meeting of the Cleveland Section when Jerry DeCroce, Supervisor of Consulting and Applicating Engineers of Westinghouse Electric Corp. spoke on this important topic.

Along with Mr. DeCroce's talk was shown the fascinating pictorial story of the A-Bomb tests at Bikini Atoll with "Operation Crossroads" the U. S. Navy Technicolor sound motion picture.

Strictly an innovation with the Cleveland Section, the wives and girl friends of the members were invited to this meeting and the free buffet supper which was served afterward.

COLORADO

J. Edward Dato, The Linde Air Products Co., Kansas City, Mo., was the guest speaker at the December 9th meeting held in Silver Wing Inn, Denver. About 75 members were present to hear Mr. Dato's talk on "Developments and Possibilities of Welding by Heliarc Process." Although Mr. Dato's talk took one hour and fifteen minutes for presentation, those present seemed to be interested throughout the entire talk. Many expressed their appreciation for such an interesting subject. Discussion followed. Following the technical session was the showing of a Reid-Avery Co. film, which was enjoyed by all.

COLUMBUS

Marion Night meeting was held on Friday, December 12th, at the Hotel Fort Hays, preceded by dinner. "The Welding of Clad Steels" was presented by Dr. William G. Theisinger, Lukens Steel Co., Coatesville, Pa. A very special invitation was extended to all residents of the City of Marion engaged in the art and science of welding to attend this meeting.

The January 9th meeting was "Zanesville Night." Dinner and technical meeting were held at the Hotel Fort Hayes. Argon-Arc Welding was the subject presented by the speaker H. T. Herbst of The Linde Air Products Company, New York. Mr. Herbst is a fully authoritative speaker on the subject, having participated in the development of the process from the early beginning. Mr. Herbst described the physics of the process and its application to the welding of aluminum, stainless alloys and other metals and alloys. The talk was illustrated with slides picturing the various characteristics of the arc. A motion picture film of an alternating-current arc in an argon atmosphere, taken at a speed of 3200 frames per second, throws a very interesting light on the problem and indicates the probable theory underlying the successful application. The second part of the paper dealt with the more practical aspects of the operation and described in a brief way typical joint designs as they compare to or are in contrast with other methods of fusion welding.

DAYTON

A Christmas Party was held on December 19th at the Elks Club in Troy, Ohio.

DETROIT

"Social Night" was the feature of the meeting held Friday evening, December 12, 1947, at the Engineering Society of Detroit.

Al Last, Chairman, presented to the 115 members and guests, Tom and Arlene Hadley and their movie entitled "Happy Valley," a very beautiful and entertaining color film of wild life in natural setting in Upper Michigan. Mr. Hadley narrated the film in poetic style.

After the meeting the members and guests retired to the dining room where sandwiches, doughnuts and coffee were served through the courtesy of the Patrons.

The Saginaw Valley Division, Detroit Section, held its monthly meeting January 8th, at the National Electric Welding Machines Co., Bay City, Mich. Approximately 200 guests and members attended, including 55 from Detroit, part of whom came the 100 miles to Bay City in a chartered Greyhound bus.

The meeting was under the chairmanship of S. Fisher and consisted of the following program.

The National Electric Welding Machines Co.'s Foundry was visited where molds were closed and aluminum castings poured. After a short interval, one of the molds was opened and a casting shaken out.

The visitors were then shown through the Company's main plant where a number of special resistance welding machines were demonstrated. An automatic muffler welder, an automotive tappet welder, a dish rack body welder and a large flash welder for fabricating kitchen sinks were operated.

In addition flash welds were made of cast-iron soil pipe. This proved to be a most spectacular display of fireworks and created considerable interest.

After the plant visitation the group was shown a colored movie of one of the Company's latest developments, namely, a high-speed barrel seam welder.

A short discussion period followed which was conducted by D. Knight, Chief Welding Engineer of National.

HARTFORD

Dinner meeting was held on Thursday, December 18th, in the Whitlock Mfg. Co. cafeteria, Elmwood, Conn. Anton L. Schaeffler, Metallurgical Engineer, Arcos Corp. Research Laboratories, presented an excellent technical paper on Selection of Austenitic Electrodes for Welding Dissimilar Metals.

January dinner meeting was held on the 15th in the Whitlock Mfg. Co. cafeteria. A. N. Kugler, Mechanical Engineer, Technical Sales Division, Air Reduction Sales Co., New York, discussed the subject of Heliwelding.

Future meetings of the Hartford Section are as follows: February 19th, Amateur Night; March 18th, Business Meeting and informal discussion on welding; April 15th, Special Meeting—Details to be announced later.

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4	125	1029
3	150	1323
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1	250	2156
1/0	300	2646
2/0	375	3381
3/0	450	4284
4/0	550	5376

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the A.I.E.E. and A.W.S. was held on Friday, December 19th, at Buckley's, Cumberland, Ind. G. W. Garman, of the General Electric Co., spoke on the subject, "Design and Function of Resistance Welder Controls." Twenty of the seventy members and guests participated in the discussion.

LEHIGH VALLEY

J. R. Morrill, Assistant to the Vice-President of The Lincoln Electric Co., was the guest speaker at the monthly meeting of the Lehigh Valley Section which was held Monday, January 5th, at Fritz Engineering Laboratory, Bethlehem, Pa. G. E. Doan, Chairman, presided at the meeting.

The dinner meeting was held in Lamberton Hall, Lehigh University. One hundred and fifty members and guests were then conducted on a tour of inspection of Fritz Laboratory, under the direction of Bruce G. Johnston.

Dr. Johnston described the testing devices used by the laboratory in compiling accurate data on the behavior of steel at various temperatures, and also told of the numerous projects undertaken by Fritz Laboratory. The tour was very educational.

Mr. Morrill spoke on "Exposing the Hidden Arc." He gave a brief history of the development of the "Hidden Arc" process, pointing out its present versatility and the remarkable future possibilities of this process. Mr. Morrill stressed the need of imagination as a key to automatic welding, and made his talk interesting and instructive by the use of slides.

Following the talk there was a demonstration of the Manual Lincolnweld. Albert Bavaria, The Lincoln Electric Co., was in charge of the demonstration, describing the machine in detail, and discussing numerous applications to which the process is adaptable. The demonstrator of the process was Paul Edelman, Bethlehem Steel Co.

MICHIANA

The Michiana Section held their December meeting on the 19th at the Bendix Legion Post in South Bend with T. B. Jefferson, Editor of *The Welding Engineer*, speaking on the subject "Recent Welding Developments." He touched on such subjects as lime-ferritic electrodes, gaseous shielded arc processes, new methods for cutting stainless, pressure welding, three-phase spot welding, and various new methods of "welding" glass, rubber to steel plastics, etc., and indicated some possibilities for their use in the future.

The talk was preceded by a Bell Telephone film on radar, which showed the principles of how echos are used to locate objects, and some of the different types of radar sets in use.

MILWAUKEE

The December meeting of the Milwaukee Section was held at the Ambassador Hotel on the 19th. Following the dinner, which was attended by approximately 40, a very interesting color film showing the principles of Jet Propulsion for airplanes was presented.

The speaker of the evening was A. M. Unger, Chief Welding Engineer of the Pullman-Standard Car Mfg. Co., Chicago. Mr. Unger presented a series of slides showing some of the details of welding as applied in car construction as well as some special spot welding equipment designed and built especially for this work. A number of slides in color showing cars of new types recently constructed were exhibited.

Some information about impedance effects in such large structures and welding of various types of low-alloy high-tensile steel to each other was given by Mr. Unger in answer to questions.

The talk and lecture lasted about one hour. The attendance at the lecture was around 60 men.

A smoker was held December 5th, similar to the one held a year ago. Entertainment by a magician was the highlight of the evening's entertainment and some of the members present were much impressed by the tricks. Card playing held the attention of some, but the broadcast of the Louis-Walcott fight drew a large part of those assembled to the radio. A light lunch and beer were served.

NEW YORK

Mr. Lyell Wilson, Research Director for American Bureau of Shipping, New York, spoke on "Control and Inspection for Quality Welds" at the New York Section meeting on January 14th. In his paper, Mr. Wilson showed that the control of material, equipment, methods, procedures, and relative workmanship constitute the most important factors in the problem of assuring high quality welding.

He emphasized the point that inspection can best be carried out by the manufacturer and that outside inspection can at best only scratch the surface. The data for Mr. Wilson's talk was obtained from 30 years experience in testing and inspection materials for marine use. At the conclusion of his talk, Mr. Wilson showed a number of slides illustrating faulty welding that caused fractures.

There were 110 who listened to this interesting paper and at least 25% participated in the discussion after its presentation.

Mr. S. A. Greenberg, Technical Secretary of the A.W.S., was Technical Chairman for this meeting. Mr. Greenberg was kept busy for almost one hour guiding the discussion. Arrangements for the meeting were in charge of Mr. G. W. Place of the American Bureau of Shipping, a member of the Executive Committee of the New York Section.

NORTHERN NEW YORK

On Thursday, November 20th, approximately 60 ladies and gentlemen gathered at the Locomotive Club to enjoy the A.W.S. Social Night. The officers of the Section were sorry that some of the members were unable to be there. During the roast beef dinner a trio entertained with music which was enjoyed by all. L. L. Wyman of the Atomic Laboratory, General Electric Co., spoke on some of the general historical events in the metallurgical science. Mr. Wyman held the interest of everyone present. The program was completed by showing movies of "Music of America."

The January meeting was held on the 29th at the Van Curler Hotel. Andrew Vogel, Chief Construction Engineer of the International General Electric Co., spoke on "Welded Buildings in Mexico." This meeting was the Schenectady Engineering Council's Meeting of the Month for January.

NORTHWEST

The regular monthly meeting of the Northwest Section was held on Friday December 5th, in the Lodge Room, Covered Wagon, Minn. A "Happy Half-Hour" was held between 6 and 6:30, which was followed by dinner. C. J. Baker, District Sales Manager of Stulz-Sickles Co. "Manganal" for the past seven years, with headquaters in Duluth and serving the iron ore properties and contractors and mines in seven northwest states, was the guest speaker. Mr. Baker's subject was "Manganese and Manganese Nickel Steel." The talk was of particular interest to grading and excavating contractors, mine operators, sand and gravel contractors, and railroad maintenance of way.

PEORIA

December 17th meeting was held in the Jefferson Hotel, Peoria, Ill. Leslie S. McPhee, Welding Engineer, Whiting Corp., spoke on "Bringing the Designer and Welder Together." Mr. McPhee is a well qualified speaker and presented his subject very well. Slides were used to illustrate the talk. Fifty-five members were present, fifteen of whom took part in the discussion. Technical Chairman was Tommy Logan of the Caterpillar Tractor Co.

PHILADELPHIA

The December dinner meeting of the Philadelphia Section was held on Monday, the 15th, in the Auditorium Engineers Club. Dr. C. B. Voldrich, Chief Welding Engineer, Battelle Memorial Institute, Columbus, Ohio, spoke on the subject, "Some Welding Research Projects of the Battelle Memorial Institute."

On Friday evening, December 5th, "Metallurgy for Welders" was presented by Anton L. Schaeffler, Metallurgical Engineer, Arcos Corp. This meeting was held in the Junior Board Room of the Engineer's Club.

Part of the Philadelphia Section's program to help more firmly establish our Society as a technical group is a plan for cooperating with other engineering societies in disseminating information about welding.

On January 16th the Philadelphia Section held a joint meeting with the Society of Naval Architects and Marine Engineers and on February 17th, Harry W. Pierce, of the Philadelphia Section, will present a talk before the American Society of Mechanical Engineers entitled "Welding from the Engineers' Viewpoint."

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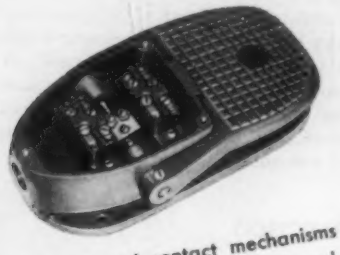

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PUGET SOUND

On Wednesday, January 7th, a joint meeting was held with the A.S.M.E. in the Engineers Club, Seattle, Wash. Professor E. Paul DeGarmo, Assoc. Prof. of Mech. Eng. at the University of California, and well known throughout the country for his work in residual welding stresses, spoke on "What We Have Learned from Our Studies of Residual Welding Stresses."

Also present were Mr. Cooper, Secretary of the A.S.M.E., and Prof. Schaller, Vice-President of District #7 of the A.W.S.

The importance of proper weld design to eliminate notches in structures as far as possible was also highlighted.

ROCHESTER

Regular monthly dinner meeting was held on Thursday, January 8th. Dinner was cafeteria style on the River Campus, University of Rochester. Meeting was held in Room 210, Engineering Building. The speaker was W. H. Simon of the Department of Mechanical Engineering, University of Toronto. Mr. Simon's talk was on Cutting of Stainless Steel. A sound movie on the recovery of magnesium from sea water by the Dow Chemical Co. process, and entitled, "Treasure from the Sea" was shown.

SAN FRANCISCO

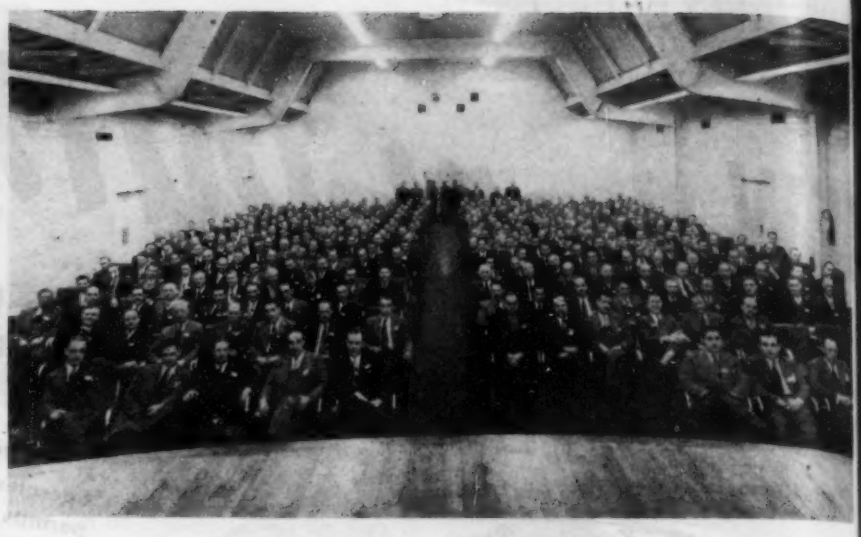
The November meeting was held on the 24th at the Engineers Club. E. W. Bartz, Welding Specialist, of the Westinghouse Electric Corp., gave an illustrated talk on Practical Applications of Automatic Welding. Motion pictures were shown in color with sound on the following subjects: Wonder Dogs in Action, and Army & Navy Football Game (with Blanchard & Davis).

SYRACUSE

L. G. Pickhaver, Field Engineer and recipient of the Coffin Award for his outstanding work with the Chicago Engineering Division of the General Electric Co., was the guest of the Syracuse Section at their January 14th meeting. His talk, at the Hotel Syracuse, covered three gas shielded arc welding processes—atomic hydrogen, argon and helium.

Mr. Pickhaver's talk was introduced by a film on atomic hydrogen welding and was accompanied with slides for illustration. This meeting was of special interest to those who have problems in welding stainless steel, aluminum, magnesium or the repairing of tools and dies.

Co-featured with Mr. Pickhaver were Joseph Shaw, senior research engineer, and Orvin Gould, both with the Utica Mutual Insurance Co. They led a talk and discussion on the subject of welding safety. This meeting and refreshments were sponsored by the Carrier Corp.



December 4th, 1947 Meeting Western New York Section

WESTERN MASSACHUSETTS

The December 10th meeting was held in the Sheraton Hotel, Springfield, Mass. Twenty-eight members were present at the dinner preceding the meeting. There was an attendance of 40 at the meeting "New Application of Inert Arc Welding' was the subject presented by R. W. Tuthill of the General Electric Co.

WESTERN NEW YORK

The November and December meetings were combined in a visit to the new Westinghouse plant at Buffalo on December 4th. This meeting was widely publicized among those interested in welding throughout western New York, as evidenced by a registration of close to 400 members and guests, some of whom traveled over 150 miles to attend. As each man registered he received a copy of the program for the evening showing the plant layout, etc., and literature concerning the SOCIETY.

After an excellent dinner in the plant cafeteria, groups were organized for a tour of the plant, each group being under the guidance of a Westinghouse representative. The tour which lasted approximately two hours was complete in every respect, as the plant was in actual operation. Observation could be made of each of the operations necessary in the manufacture of a.-c. and d.-c. motors of various sizes as well as those necessary in the manufacture of a.-c. and d.-c. welding equipment. Numerous welding operations were in use on the production lines and proved to be exceptionally interesting.

Following the tour of inspection, guests and members were duly welcomed by the Section Chairman, C. E. Jackson, H. B. Vidal, Westinghouse District Manager, and L. R. Ludwig, Plant Manager. Mr. Ludwig explained the organization and operation of the plant. His explanation, together with the shoe leather which was worn out during the tour of inspection, made possible a deep appreciation of those things which are necessary in order to operate such a tremendous plant.

George M. Trefts III, District Vice-President, presented a discussion of the many benefits which could be derived from membership in the A.W.S. In view of his sincere interest in this subject, his talk should have convinced those present that they could not pass up the opportunity of joining the SOCIETY.

Charles H. Jennings, A.W.S. Director, and Manager of Welding Engineering, Westinghouse, presented an address on "New Developments in A.-C. Welding." In his talk he covered the history of a.-c. welding up to the present day, together with the history and development of inert-gas shielded arc welding using a.-c. equipment. Slides and a color movie on "The Advantages of A.-C. Welding" accompanied the address.

F. V. Schilling, Program Chairman, lead the discussion which followed. Considerable interest in inert-gas shielded arc welding was evidenced by the questions presented during the discussion.

CANADIAN

Third meeting of the 1947–48 season of the Montreal Chapter of the Canadian Welding Society was held on Monday, Dec. 22, 1947, in the Cartier Room of the Berkeley Hotel. This was a "Stump the Experts" Night with five experts as follows: J. S. Johnston, Dominion Oxygen, A. H. Boehm, Steel Co. of Canada, Russ Holden, Canadair, C. E. Raymond, Crane Ltd., and Y. Gratton, Ecole des Arts, Metiers. Master of Ceremonies was Russ Dunn, Canadian Liquid Air.

Fourth meeting of the 1947–48 series of the Hamilton Chapter were held on Tuesday, January 6, 1948, at McMaster University, Hamilton. "Control of Quality and Methods of Inspection in Welding" was the subject presented by H. J. Nichols, Welding Metallurgist, Bureau of Mines, Ottawa.

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List of New Members

December 1 to December 31, 1947

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Metcalf, William B. (B)

BRIDGEPORT

Axley, Robert C. (B)
Murray, William James (C)
Powers, James J. (C)

CINCINNATI

Moenster, Clemens A. (C)

CLEVELAND

Connelly, Daniel S. (B)
Hallstein, Harold A., Jr. (B)
Wyatt, Donald L. (B)
Johnson, Herbert F. (C)
Orland, John B. (C)
Young, William J. (C)

COLUMBUS

Block, Wm. E. (C)
England, Robert H. (C)
White, Charles, (C)

DAYTON

Staehlin, Ralph H. (B)

DETROIT

Brown, Hugh A. (C)
Burch, Guy E. (C)
Coltson, Stanley (C)
Dixon, George (B)
Drabicki, Edward J. (C)
Dunn, Stephan J. (B)
Elston, A. C. V. (C)
Fitch, Jonathan (C)
Harms, Alfred (C)
Houck, H. D., Jr. (B)
Houck, H. D., Sr. (B)
Liljergren, Paul (C)
Machcinski, Eugene (C)
Neef, William (B)
Peters, Raymond A. (B)
Ratcliffe, Sidney K. (C)
Sanavage, Anthony (C)
Tromans, Harold (C)

HARTFORD

Garvey, James V. (C)
Recor, George A. (C)

ISLAND EMPIRE

Haxton, William (B)

LONG BEACH

De Pietro, P. Paul (C)

LOS ANGELES

Burk, Kenneth S. (C)

MAHONING VALLEY

Kuhlke, O. H. (B)

MARYLAND

Girton, Fred C. (C)
Hlavin, Warren Edward (C)

MILWAUKEE

Boettner, Fred W. (C)

NEW JERSEY

Ballinger, Vernon (C)
Meyer, John (B)
Smith, Richard P. (C)

NEW ORLEANS

Allen, Ethan (C)

NEW YORK

Barbolini, Guy M. (B)
Barry, Jack J. (C)
Mackler, Eugene (B)
Martin, Roger M. (B)
McCord, Earl K. (C)
McNally, Rard J. (B)
Oatley, Henry B (B)
Powers, Richard E. (I)
Schuster, William H. (C)

NORTHWEST

Belz, Herman E. (B)
Benjamin, Paul (C)
Glaeser, R. C. (C)
Hanson, Peter (C)
Henninger, Edgar A. (C)
Kontos, Ralph (C)
Miller, Frank (C)
Shields, G. C. (C)
Suchomel, Carl P. (B)
Swenson, S. K. (C)
Waresh, John P. (C)

OKLAHOMA CITY

Symns, E. (C)

PASCAGOULA

Peattie, D. G. (C)

PHILADELPHIA

McGinley, J. D. (C)

PITTSBURGH

Christ, J. G. (B)
Samson, H. I. (C)

ST. LOUIS

Joos, August G. (C)
Moore, Charles N. (C)
Wulfert, Otto (C)

SAN FRANCISCO

Laymon, Earl F. (B)
Pohndorf, Henry L. (C)
Roach, Justin M. (C)
Witten, Wayland F. (C)

TULSA

Silvers, Floyd L. (B)

WASHINGTON

Pugacz, Myron A. (C)
Stogner, William H. (C)

WESTERN MICHIGAN

Knape, Herbert F.
Mallard, Andy (B)

WESTERN NEW YORK

Klopfer, Edward L. (C)

NOT IN INSECTIONS

Capek, Vaclav (B)
Galinato, Juan G. (C)
Rasmussen, John C. (B)
Sorensen, Lars Kristian (B)

Members Reclassified During Month of December

CHICAGO

Cavanagh, J. O. (C to B)

NEW JERSEY

Scarince, William (C to B)

NOT IN SECTIONS

Joyce, Edwin (C to B)

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 10, D. C.

2,431,325—Method of Electrically Welding Metal Keys to Metal Can Ends Having Protective Coatings of Limited Extent—John G. Hayes, San Mateo, Calif., inventor, assignor to American Can Co. (4 Claims)

This special welding method consists in bringing an uncoated portion of the coated surface of a can end into engagement with an electrode and the positioning of an opening key with a welding projection thereon against the opposite uncoated surface of the can end. A second electrode is pressed against the key to force the projection thereon into engagement with the can after which the key is welded to the can by passing an electric current between the electrodes and through the engaged metal parts of the key and can end.

2,431,368—Method of Electric Arc Brazing—Sidney J. Cherry, East Orange, and Leo C. Werner, Bloomfield, N. J., inventors, assignors to Westinghouse Electric Corp. (3 Claims)

Another special fabrication method is covered in this patent and it relates to the formation of electron discharge devices. Metallic parts are to be secured together

at a junction therebetween and a brazing material is supplied to the junction between the parts. A source of electrical current is applied to one of the parts at a distance from the junction and an electrical arc is struck from such one part clear of the junction in the vicinity thereof and between the junction and the point of current application. Thus the arc-forming current does not traverse the junction, but heat of conduction traveling to such junction will melt the brazing material thereon.

2,431,675-2,431,676—Dispensing Container for Acetylene and Method for Storing Acetylene—Robert C. Bour, Chicago, Ill., inventor, assignor to National Cylinder Gas Co. (11 Claims)

Bour's patents relating to the storage of acetylene generally require the provision within the storage receptacle of a solid absorbent material impregnated with an ester of carbonic or phosphoric acid derived from an alcohol containing not more than 6 carbon atoms.

2,431,689—Welding Rheostat—Edwin E. Foster, Austin, Tex., inventor. (14 Claims)

The patented welding rheostat comprises a pressure-applying device adapted for use with electric welding apparatus and systems and it includes an eccentric shaft rotatably mounted on the apparatus and a pressure-responsive rheostat positioned under the eccentric shaft. Pendulum means are secured to the eccentric shaft to apply and release pressure on the rheostat periodically as the pendulum swings along its shaft. The pendulum includes a leaf spring secured at one end to the eccentric shaft and having a weight at its free end.

2,431,732—Locating and Welding Fixture—Edward Colbert, Chicago, Ill., inventor, assignor, by mesne assignments, to the United States of America. (5 Claims)

This patent covers a special type of fixture for locating parallel guide members adjacent to the inner wall of a bonnet for welding them thereto.

2,431,743—Apparatus for Electrically Welding Spiral Tubing—David Wendell Fentress, Barrington, Ill., inventor, assignor to Chicago Metal Hose Corp. (6 Claims)

A tube-making machine having a rotatable mandrel and means for winding an elongated strip upon the mandrel to bring the edges of the strip into juxtaposed position is covered in the patent. The machine also has means for welding the juxtaposed strip edges together so as to form a welded tubing structure, which welding means include a welding roller engageable with the outer surface of the strip and an elongated electrode wire adapted to be interposed between the tubing strip and the mandrel.

2,431,781—Method and Apparatus for Applying Metal Coatings—Robert L. Wagner, Niagara Falls, N. Y., inventor, assignor to Haynes Stellite Co. (22 Claims)

Wagner's patent covers apparatus for welding an overlay of protective metal upon the surface of an article, which surface is intersected by the axis of rotation of the article. The article is supported for rotation and is rotated with the surface to be coated uppermost and a row of bodies of protective metal is brought into contact with successive portions of such surface within an elongated welding zone upon the surface of the article as it is rotated. The welding zone extends substantially from the axis of revolution of the article to an outer margin of the surface. Torch means direct welding flames within the welding zone and upon the bodies of the protective metal. Such welding flames are reciprocated with such bodies of protective metal in unison along paths contacting the surface of the article within the welding zone. Supplemental welding heat is directed upon a surface of the article remote from the first-named surface to facilitate the deposit of protective metal.

2,431,975—Method of Welding Carbon to Molybdenum—Hubert P. Yockey, Oakland, and James M. Nuding, Berkeley, Calif., inventors, assignors to the United States of America. (3 Claims)

This welding method comprises heating two contacting materials, one of which is carbon and one of which is molybdenum with an atomic hydrogen flame while substantially contacting such materials with a molybdenum welding rod.

2,432,019—Welding Electrode Holder—Walter J. Koinzan, Elgin, Nebr., inventor. (1 Claim)

The patented electrode holder includes a tubular handle made from insulation, a cable clamping member in the handle and a combined cable and electrode clamping rod received within the cable clamping member and extending therefrom. A tubular perforated shield surrounds the said rod and the various parts are in threaded engagement whereby rotary movement therebetween can effect a clamping of the electrode in the electrode holder.

2,432,048—Welding Electrode—Henry Jackson Stretton, Gateshead-on-Tyne, England, inventor, assignor to Fusarc Ltd. (1 Claim)

Stretton's electrode has a metal core with a mesh-like metallic sheath thereover. The sheath includes at least two oppositely coiled wire helices, each layer of which includes at least two helically positioned wires, and a coating of flux material is incorporated with the sheath and leaves exposed only the outer surface of the outer layer thereof.

2,432,495—Welding Apparatus—Albert W. Baird, Cranford, N. J., inventor, assignor to The Linde Air Products Co. (11 Claims)

The patented welding apparatus comprises a mobile carriage on which is mounted a welding rod supply reel, a rod feeding and guiding device and means for receiving the rod and conducting welding current thereto. A motor is provided to drive the carriage and rod feeding device and one member supports the welding rod supply reel and the rod feeding and guiding device. This member is tiltable as a unit with respect to the carriage so that either butt-welding or fillet-welding operations can be performed without changing the rod feeding load on the motor.

2,432,529—Arc Welder Control Circuit—Albert R. Locke, Oak Park, Ill., inventor. (7 Claims)

Locke's control circuit includes a core reactor having a main winding and a control winding with the main winding being connected in the load circuit. Unidirectional current is supplied to the control winding and automatic means for varying the value of such unidirectional current as a function of the variation in resistance of the electric arc are also associated with the control circuit.

2,432,631—Method of Electric Welding Metals of Different Electrical Resistivities—Robert W. Rosendale, Westfield, N. J., inventor, assignor to Western Electric Co., Inc., New York. (2 Claims)

In the patented welding method, a high-specific electrical resistance metallic member is associated with a low-specific electrical resistance metallic member and portions of like contours are punched from the members to leave apertures therein after which the high-specific electrical resistance metallic portion is forced partially into the aperture of the low-specific electrical resistance metallic member. Next a second low-specific electrical resistance metallic member is positioned adjacent the first low-specific electrical resistant member and in contact with the projecting portion thereof, and an electrical welding current is passed through the said projecting portion in the said aperture and the portions of the two low-specific electrical resistance metallic members in contact therewith to cause a fusion in the path of the current.

2,432,639—Dielectric Welding Rod Holder—Roger M. Webster, New London, Conn., inventor. (9 Claims)

The novelty of this patented welding device resides in a connector member which is received in a handle and has compressed air supplied thereto. The handle forms a part of a holder which is adapted to discharge expanded air around a welding rod positioned thereby.

2,432,750—Self-Cleaning Electrode—Norman H. Goldsworthy, New York City, inventor, assignor to Continental Can Co. (5 Claims)

This patent relates to a spot-welding machine wherein a reciprocable bracket yieldably supports a welding head. An electrode and an electrode holder are positioned on the head and adapted to be turned when moved relative to the head. Adjustable yielding means, with limited movement, are provided for positioning the holder on the head.

2,432,761—Method of Electric Resistance Welding Head Closures to Hollow Valve Bodies—Joseph H. Hoern, Birmingham, Mich., inventor, assignor to Eaton Mfg. Co. (2 Claims)

This patent specifically relates to the manufacture of a poppet valve of the liquid-cooled type of the class wherein there is a main body portion of weldable material consisting of a cylindrical stem portion and

a concentric outwardly flared end portion. In the welding method, a disk of weldable metal has a concentric rib of approximately the mean diameter of the axially outer face of the main body portion formed thereon and such disk is pressed against the free end face of the main body portion with the rib forming the sole line of contact therebetween. An electric current of sufficient strength is passed between the disk and main body portion to fuse same together with the resulting flash flowing radially outwardly of the valve.

2,432,773—Coated Welding Electrode—Richard K. Lee, York, Pa., inventor, assignor to The McKay Co. (5 Claims)

Lee's electrode is adapted for welding low-alloy high-tensile steel wherein the electrode has a carbon, silicon and manganese content adapted to deposit weld metal comprising about 0.03 to 0.30% carbon, about 0.05 to 1.25% silicon and about 0.30 to not over 1.25% manganese. The electrode also is adapted to provide a shielding atmosphere of carbon monoxide and carbon dioxide adjacent the weld zone.

2,432,836—Electrode Holder—William A. Ternes, Detroit, Mich. (1 Claim)

In this electrode holder, a jaw assembly for retaining welding material is controlled by a handle member and a switch is provided for controlling the connection between the jaws and a source of power. Individual controls are provided for the switch and the jaws and are operable by the hand of a user grasping the handle of the holder. Only one of such controls can be actuated at one time by a person grasping the electrode holder.

2,433,018—Adjustable Electrode Holder—Bela Ronay, Annapolis, Md., inventor. (7 Claims)

This holder is for tubular electrodes and has a handle portion with fluid and electrical connections extending therethrough. An adjustable union is provided between the handle and electrode grasping means and adapted to conduct both fluid and electrical current to the electrode.

2,433,164—Welder's Helmet—Raleigh T. Shields, Newport News, Va., inventor. (4 Claims)

The patented welder's helmet includes an eye shield which is mounted on arms that are hinged on the circular band adapted to embrace the head and temples of the wearer. A releasable spring retained latch is associated with the arms and eye shield to hold the eye shield in and out of the way position when the helmet is in a raised position.

2,433,296—Gas Carrying Mandrel for Pipe Welding—Walter S. Schaefer, Cleveland, Ohio, inventor, assignor to Republic Steel Corp. (10 Claims)

The mandrel comprises a hollow cylinder open at its trailing end and a rod extends from the cylinder beyond its trailing end. A gas-pressure regulator is provided at the trailing end of the rod and includes a tube having a spring pressed closure at its trailing end. Means also are provided for delivering a nonoxidizing gas under pressure into the interior of the cylinder.

OBITUARY

Joseph F. Kordic

Joseph F. Kordic, owner of the Kordic Welding Works, Portland, Ore., died suddenly at his home on Oct. 29, 1947. Mr. Kordic was born in Yugoslavia and came to this country at the age of 17. In June 1921 he went to work at the Electric Steel Foundry, Portland, Ore., as a welder. He was so employed until February 1945 when he opened a welding shop of his own, which he has since operated. Mr. Kordic is survived by his wife, Violet, and two children, Marilyn and Joseph, Jr.

* * *

Frederick P. Huston

Frederick P. Huston, engineer and metallurgist in the Development and Research Division of The International Nickel Co. Inc., at New York, died at the Muhlenberg Hospital, Plainfield, N. J. on Monday, December 29th, from the effects of a heart attack he had suffered recently at his home, 281 South Ave., Fanwood, N. J. He was fifty-seven years old.

Mr. Huston was in charge of developments in the application of nickel alloys in the railroad field for International Nickel's Development and Research Division. He had been with the Company for over twenty years, having joined its Technical Service Section in October 1927. Previous to his appointment as head of the Division's railroad developments in February 1945, he had been associated with the INCO Mill Products Division for about five years, devoting considerable time to the problems of steam locomotive maintenance, particularly boilers and fireboxes.

He aided in the development of methods used for the production of nickel-clad steel plate and was co-inventor of a process used for producing Inconel-clad or stainless-clad plate.

Mr. Huston studied engineering at the University of Missouri and was graduated in 1912 with a degree of B.S. in Electrical Engineering. He was a member of the American Welding Society, the American Society of Mechanical Engineers, the Master Boiler Makers Association, the American Railway Engineering Association, New York Railroad Club, Railroad Machinery Club of New York, Railway and Locomotive Historical Society, Railway Supply Manufacturers' Association and Western Railway Club.

Mr. Huston was born at Sweet Springs, Mo., the son of the late Mr. and Mrs. Frederick K. Huston. He is survived by his wife, Mrs. Minerva E. Ferguson Huston, two daughters, Doris (Mrs. Charles H. Kennington, Jr.) and Jean F., both of Fanwood, a son Frederick P. Huston, Jr. metallurgist with the Huntington Works Research Laboratory of International Nickel, at Huntington, W. Va., and three grandchildren, Susan Ross Huston, Frederick P. Huston III and Patricia Jean Kennington.

Employment Service Bulletin

SERVICES AVAILABLE

A-555. Welding supervision or inspection work desired. Experience includes 4½ yr. inspection work on pressure vessels—field and shop welded; 4 yr. welding supervision, manual and automatic. Coated and bare electrodes and inert gas experience on stainless and aluminum. Familiar with silver solder brazing; also spot and projection welding.

A-556. Graduate mechanical engineer, age 28, thoroughly familiar with the theory of all types of gas and electric welding, desires welding engineering position with well established organization. Practical experience includes 6½ years of experimental research and test engineering. Capable of writing specifications and technical reports. Will seriously consider all replies. Location immaterial.

A-557. Have been welding for past eleven years, electric and gas, also, burning. Have worked in Central America for three and one-half years. Held positions of Foreman, Naval Inspector and Instructor. Will accept employment anywhere in the United States or abroad, preferably in Cuba. Further details upon request.

OXYACETYLENE WELDING TORCH

The Air Reduction Sales Co. has announced the immediate availability of a new oxyacetylene welding torch, the Airco 800. According to the manufacturer, this new torch has a number of distinct advantages over torches currently on the market. Although the new torch has a conventional weight of 1½ lb. and is only 11½ in. long, it has a capacity for operating single flame welding tips from Nos. 0–13 inclusive as well as multiflame tips up to No. 15. This means that the new Airco 800 is suitable for almost any welding job from the thinnest sheet metal up to 1½ in. in thickness. The manufacturer states that no other comparable welding torch can offer this extremely wide operating range.

Outstanding advantages include the following:

1. *Better Flame Control*—Each welding tip is assembled with an individual mixer drilled for that particular size tip thus assuring better flame control and weld results. (The complete welding tip assemblies are available in sizes 0–10 only.)

2. *Low Maintenance Costs*—The torch head of the new Airco 800 is made of durable, long-wearing monel metal. This means fewer torch head replacements and also lower maintenance costs because rarely, if ever, is reseating required.

3. *Modern Design*—The general design of the new Airco 800 plus the light weight, flexible ¼ and 5/16 in. I.D. hose used with this torch assures perfect balance and ease of manipulation.

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